

GOVERNMENT OF INDIA

DEPARTMENT OF ARCHAEOLOGY

**CENTRAL ARCHAEOLOGICAL  
LIBRARY**

---

CALL No. **913** **Bra**

D.G A. 79.

X  
INDUSTRIAL BOOK DEPOT  
Ph. 20201  
JAWAHAR NAGAR  
DELHI-6

139





ANCIENT  
LANDSCAPES





*School of Archaeology,*

# ANCIENT LANDSCAPES

*Studies in  
Field Archaeology*

By

JOHN BRADFORD, M.A., F.S.A.

*University Demonstrator and Lecturer  
Pitt Rivers Museum, Oxford*

17783



913  
Bra

LONDON  
G. BELL AND SONS, LTD

1957



CENTRAL ARCHAEOLOGICAL  
LIBRARY, NEW DELHI.

Acc. No.....17783.....  
Date.....25-11-59.....  
Call No.....913/ Bla.....

To  
A. M. B. B. AND P. F. B.

Beneath me in the valley waves the palm,  
Beneath, beyond the valley, breaks the sea;  
Beneath me sleep in mist and light and calm  
Cities of Lebanon, dream-shadow-dim,  
Where Kings of Tyre and Kings of Tyre did rule  
In ancient days in endless dynasty.  
And all around the snowy mountains swim  
Like mighty swans afloat in heaven's pool.

JAMES ELROY FLECKER, *Brumana* (1913)





## PREFACE

THIS BOOK is based on University lectures which I have given during the last ten years at Oxford, on annual expeditions overseas for field-work, and on experience originally gained while working with air photos during the Second World War as an Army officer.

The publication of *Wessex from the Air* by Crawford and Keiller in 1928 consolidated a systematic foundation for the archaeological study of air photographs. Thenceforth the technique was securely established among those at Archaeology's right hand, but only one book<sup>1</sup> on this subject was published in Britain during the twenty-eight years following. Even a frequent succession of articles has not been able to keep pace with its use.

The reader will soon perceive how greatly my book is indebted to the Air Ministry for permission to reproduce Royal Air Force photographs taken in 1943-45, which were noted by me at that time as important for archaeological study when peace came. First and foremost, therefore, I wish to make grateful acknowledgement of the Air Ministry's courteous consent. I have much in mind, too, friends and fellow members of the Services in those days who were concerned with air photographs; they played a potent part in ensuring the victory on which the continuation of liberal science in turn depended. It should give sober satisfaction that photographs for which lives were risked, and lost, continue to be of value many years afterwards, making fresh contributions to knowledge in the Study of Man.

This book does not aim to catalogue *all* the present and future potentialities and techniques within the scope of Air Archaeology, but enough to suffice for its practical purpose:—to facilitate the recovery of ancient landscapes comprehensively over large areas.

Sir Mortimer Wheeler has reminded us<sup>2</sup> that military and archaeological field-work share some basic principles. It was soldiering which helped General Pitt Rivers to acquire the sharp eye he turned on ancient earthworks, as well as the powers of analysis with which he formulated the principles of modern stratified excavation seventy years ago,—nor would it be difficult to name others whose archaeological outlook owed much to a military training in observation. Precise observation is likewise the prime consideration in all uses of air photographs. During the last War topographical work in an unparalleled variety of

<sup>1</sup> *Monastic Sites from the Air*, by Prof. D. Knowles and Dr. St. Joseph, 1952 (in the series of Air Surveys planned by the Cambridge University Press). As arrangements have been made for publishing the notable photographs of British sites taken by the late Major Allen and by Dr. St. Joseph, my illustrations have been taken from other sources to ensure a wider representation.

<sup>2</sup> *Archaeology from the Earth*, 1954, 4, 11.



landscapes demanded rigorous standards *and* the exercise of controlled imagination, so giving experience a keener edge.

It has been as the result of more exact observation and the use of suitable technical methods that the tempo of discovery in archaeology has reached its present peak and is accelerating every year. It is significant that at a moment when the present is electric and the future atomic, the interest in and study of the past is more widespread and active than ever before. As I write these words Professor Lord Cherwell is 'splitting atoms' in an adjacent laboratory, and a few yards away the biologists are closing in on the essence of life itself. Even beside such transcendental manoeuvres, archaeology's progress in charting human history is no small matter; a particularly important development is the increased emphasis on piecing together *social units* whether large or small, as contrasted with the continual sampling of sites. To this current trend in practical policy, the universality and comprehensiveness of aerial survey are appropriate.

No technical method is self-sufficient. Often the plan of a site found from the air is distinctively characteristic of its period. But in regions less known in archaeology, only tentative dating is possible. It follows that aerial exploration increases the need for field-survey on foot. Logically, too, every page in this book should bear the rubric: 'Please excavate'. Most archaeologists will conclude that every region and country should have its archaeological planning-staff, with a list of specific problems arranged in order of priority. It is a proven fact, as the following pages show, that even the most famous sites and problems can be made to yield major discoveries when subjected to modern methods.

Speed, *per se*, is not necessarily a prime consideration, but when combined with precision it becomes so. The work of Colonel Baradez, for example, has shown how the study of a series of vertical air photos achieved a detailed map of an area of Roman Algeria in a fraction of the time needed by an expedition simply confined to the ground. The result was more than a localised advance in our knowledge of one region; it also contributed to judgements of far wider importance, i.e. to the *comparative* study of the life and times of the Roman farmer throughout the provinces,—the 'family man' on whom so much depended.

To quote a shrewd comment by Sir Mortimer Wheeler, 'The *provincialisation* of history has still far to travel'. Archaeology has a dual rôle to play regionally, making comparisons in *space* (e.g. the similar centuriated systems in Chapter IV) and also in *time* (cp. Chapter V). The latter illustrate the episodic but continuous evolution of a particular district. For example, on the Foggia Plain in South Italy, a single vertical air photo can map a Neolithic *kraal*, a Roman estate, a derelict medieval drove-way for cattle, and a modern settler's farm built by the State,—all side by side. This part of Apulia showed the evidence of cultural rise and fall with phenomenal clarity and completeness (Chapter II), and one can see the past and present linked by an evolutionary thread that had often



been twisted but not completely cut,—a palimpsest of landscapes, dead, atrophied, and flourishing. Metaphorically, and in fact, all countries display on permanent exhibition a 'gallery' of landscapes by old and new 'masters'. Those in Britain were the theme of Jacquetta Hawkes's evocative book *A Land*.

The study of the past requires a constant refining of analysis. The 'total' mapping of the ancient landscapes to be described is the latest expression, on a larger scale, of the policy which General Pitt Rivers inaugurated in excavation: the total and impartial recording of *everything* found. On an air photo of an ancient site, whether city or farm, the essential details may be represented by very small lines on the print, but one becomes accustomed to this and one cannot complain when modern microscopists measure by units as small as the millimicron.

Successful strategy depends on the right tactics. There are some types of site by nature unsuited for air archaeology; like the use of a mouse-trap to catch a butterfly, the method is inappropriate. In the pages on 'Scope and Limitations of Search' (pp. 75-82) I have given some examples of terrain unsuitable for aerial discovery. Another instance was given by my study of an air survey mapping the coast of British Somaliland. The sites of former towns are known from ground reconnaissance, but they are obscured by drifts of sand. For this reason, few outlines of buried structures could be seen on the photos. Cyprus is another good example; the island is crowded with ancient sites but many are covered by 5 feet or more of soil,<sup>1</sup> so that buried walls (especially of mud-brick) are less likely to produce crop-marks; in addition, suitable types of site enclosed by ditches are rare. In September 1955 I spent several weeks in Cyprus and examined some thousands of air photos taken by the Royal Air Force for mapping in 1949.<sup>2</sup> They had been taken in the spring, and at 1 : 10,000 scale; i.e. under conditions which would have recorded crop-marks which revealed any important class of buried site. But a tour of representative sites showed that field-work on foot and surface finds of pottery, etc., are more productive of discovery than the air view. However, the air photos, although of limited assistance, provided discoveries which showed that the general principles of air archaeology were valid in Cyprus as elsewhere. (i) Grass-marks revealed the buried outlines of some large rock-cut Hellenistic tombs along the coast near Nea Paphos, (ii) a 'bird's-eye view' of the low-lying area, still known as *Limni* (the lake), on the north edge of the site of the classical city of Salamis strongly suggested the presence of a large ancient harbour now silted up.

It is a primary duty to make one's findings readily available, not only to specialists but to a wider public. Many of the finds in this book were included

<sup>1</sup> Similarly at Cyrene in North Africa the discovery-potential of excellent large-scale verticals (taken by Hunting Aerosurveys) was limited by the fact that a depth of 12 feet of soil and rubble overlay some of the buried buildings of the city, as excavation showed.

<sup>2</sup> I am grateful to the Director of the Department of Lands and Surveys in Nicosia for permission to study them, and to Mr. A. H. S. Megaw and Mr. Hector Catling of the Department of Antiquities for their help then and since.



in an exhibition of air photos which has visited over twenty museums and six public schools in England; many have been shown abroad, e.g. at lectures given at the Accademia di S. Luca in Rome and at Copenhagen to the International Classical Congress, and exhibited at Varese Museum and elsewhere.

Assistance has been given, also, to many archaeologists and historians in obtaining and studying air photos for use in their researches in countries from Europe to South-east Asia.

Experiments have been made, too, in the practical demonstration *from the air* of actual sites. When the meetings of the Classical Societies (1948), and of the Permanent Committee of the Prehistoric Congress (1955), took place at Oxford aeroplanes were chartered, on the first occasion a De Havilland 'Rapide' by the Pitt Rivers Museum, on the next a 'Dove' by the British Academy and Professor Hawkes. Aircraft of high-wing type were chosen, giving a good view all round. On these two flights (at a height of 1,000 feet) dozens of earthworks and other sites were shown to fifteen eminent European archaeologists, who had been supplied with annotated maps and data on the itinerary. The author, acting as observer and map-reader, assisted the pilot to find the selected sites along the routes specially planned. Instead of 'next slide please' as in a lecture, a sequence of the sites themselves, in their natural setting, passed in calvacade beneath our eyes, and each one was inspected in turn. Days of excursions on the ground were thus compressed into a few hours: the circular route of the aerial demonstration in 1955 was 250 miles long.<sup>1</sup>

\* \* \* \* \*

The work described in the following chapters formed only a part of a busy routine of university duties. Therefore I am glad to express my special thanks to the Curator (Mr. T. K. Penniman) of the Pitt Rivers Museum, Oxford, for the generous scope for research in this University department. Gratitude is also due to the Director and staff of the British School at Rome, especially for Mr. Ward Perkins's help when our combined efforts secured the preservation of a large number of British air photographs at the end of the War; to the *Soprintendenze alle Antichità* of Puglia and of Etruria for their courteous co-operation during my excavations and reconnaissances; to the Ashmolean Museum for invaluable facilities in the use of the Library; to Staff Officers of the Italian Air Ministry; and to my publishers, G. Bell and Sons Ltd.

Grateful acknowledgements are made to all those who generously have provided grants in support of my explorations overseas since 1945, to the Leverhulme Trustees, the British Academy, the Society of Antiquaries, the Pilgrim Trust Fund, the Craven Committee and the Higher Studies Fund of the University of Oxford, and others to whom I am sincerely grateful. I wish also to give thanks for a helpful grant from U.N.E.S.C.O. when lecturing to the Second International Congress of Classical Studies at Copenhagen in September 1954,

<sup>1</sup> A description of this flight has been given by Prof. R. Vaufrey in *L'Anthropologie*, 1956, 578-584.



—and likewise from the Fondazione Lerici, when I was invited to attend the planning conference on air archaeology in Italy which took place at the Direzione Generale delle Antichità e Belle Arti, in Rome in December 1954.

This is a welcome opportunity to express appreciation of the help given by friends and colleagues in many countries. I am deeply grateful to Sir Mortimer Wheeler for his teaching, friendship, and inspiring example in the practice of field archaeology. To Dr. O. G. S. Crawford I owe much for the energetic encouragement he has given to air archaeology from the Cotswolds to Cochin China. Much help has been given by Ing. Lerici. Professor C. F. C. Hawkes and Sir Mortimer Wheeler read the typescript of Chapter II. Professor Plinio Fraccaro (Rector of the University of Pavia) and Mr. C. E. Stevens, with their usual liberality, have given their expert views on the new facts and old problems discussed in Chapter IV. In Chapter V, Professor Axel Boëthius of Göteborg University contributed valuable advice on the system of buried streets which I found in the city of Paestum; my study of this, and of discoveries in Attica and Rhodes, also benefited from the wise counsel of the late Mr. T. J. Dunbabin and the late Sir John Myres. The section on Cosa is much indebted to Professor F. E. Brown for his unique knowledge of this site. Mr. Russell Meiggs has most generously and helpfully commented on the problems at Ostia, and Professor I. A. Richmond has likewise advised on the topography of Roman Verona.

The following pages mention many others who gave kind assistance; for example, Professor P. Barocelli, Brigadier Bomford, Professor V. G. Childe, Dr. G. E. F. Chilver, Dr. G. E. Daniel, Professor N. Degraasi, Professor E. Dyggve, Professor C. Drago, Mr. C. W. T. Eliot, Mr. R. G. Goodchild, Dr. D. B. Harden, Dr. J. M. Houston, Dr. I. D. Kondis, Mr. E. M. Jope, Mr. Seton Lloyd, Professor G. Lugli, Mr. I. D. Margary, Professor P. C. Sestieri, and Professor Rodney Young. Special thanks are due to my friend Dr. J. S. Weiner.

I am deeply indebted to the Air Ministry for assistance in these researches and for their kind consent to the publication of numerous photographs taken by the Royal Air Force, all those which are labelled as 'Crown Copyright Reserved'. Also, special thanks are due to the Director<sup>1</sup> of the Institut Géographique National (for pls. 49a, b), to the University Museum, Philadelphia (pls. 21-23), Hunting Aerosurveys (pl. 24), Aerofilms Ltd. (pls. 17, 19, 20), and Mr. Keith Jopp (pl. 4b). The remaining photographs were taken by myself, from the air and on the ground.

It is a particular pleasure to record my thanks to my wife for her help with the field-work and the preparation of this book.

JOHN BRADFORD

*Pitt Rivers Museum*  
*University of Oxford*  
1955-56

<sup>1</sup> M. l'Inspecteur Général Hurault. Grateful acknowledgement is also made to M. Charles Saumagne, and to MM. Hurlaville and Caillemer, for their help in obtaining French air photos.





# CONTENTS

|   | <i>Page</i> |
|---|-------------|
| I AIR ARCHAEOLOGY: ITS PURPOSE AND PRACTICE                         | I           |
| II RECONSTRUCTING A PREHISTORIC LANDSCAPE: THE FIRST PHASE          | 85          |
| III ETRURIA FROM THE AIR  | 111         |
| IV ROMAN CENTURIATION: A PLANNED LANDSCAPE                          | 145         |
| V THE CHANGING FACE OF EUROPE: CLASSICAL AND MEDIEVAL<br>TOWN PLANS | 217         |
| INDEX   | 287         |

## LIST OF TEXT FIGURES

|  | <i>Page</i>       |
|--|-------------------|
| 1 Air photo interpretation of marks in Normangate Field near Castor  | 21                |
| 2 The area covered by ancient fields on, and below, the slopes of Mt. Hymettos near Athens                 | 30                |
| 3 A photographic sortie plotted on the map for reference   | 60                |
| 4 A method of transferring details from a vertical air photo to a map                                      | 64                |
| 5 Neolithic Apulia, in relation to other Mediterranean foci  | 87                |
| 6 Etruscan cemeteries round Cerveteri  | 117               |
| 7 Diagram to show how a levelled Etruscan tumulus causes vegetation markings                               | 119               |
| 8 Aerial plan of 200 of the levelled tumuli mapped in the Banditaccia cemetery north of Cerveteri          | 120               |
| 9 Aerial plan of 600 levelled tumuli on Monte Abetone south of Cerveteri                                   | 128               |
| 10 Aerial plan of 800 levelled tumuli, and buried roads, in the Etruscan cemetery on Monterozzi, Tarquinia | <i>facing</i> 132 |
| 11 Aerial plan of an Etruscan cemetery mapped from the air at Colle Pantano                                | 140               |
| 12 The <i>groma</i> in use by a Roman surveyor   | 151               |
| 13 Centuriation at Cesena  | 158               |
| 14 Remains of <i>limitatio</i> near Tricesimo  | 171               |
| 15 Areas of centuriation found at Zara and on Ugljan   | 179               |
| 16 Map of the system at Zara   | 181               |
| 17 Centuriated system discovered at Salona   | <i>facing</i> 184 |
| 18 Area occupied by ancient gridded roads on Hvar, mapped from the air                                     | 192               |
| 19 The chief centuriated zones in Tunisia  | 196               |
| 20 Centuriation at Valence, mapped from the air  | 207               |
| 21 Paestum: the buried street-plan as revealed by crop- and soil-marks                                     | 219               |
| 22 Cosa and its silted harbour   | 228               |
| 23 Ostia: ancient topography   | <i>facing</i> 238 |
| 24 Roman Verona and the course of the Adige  | 258               |
| 25 The street-plan of the Classical city of Rhodes, prepared from ground-air archaeology                   | 278               |

## LIST OF PLATES

|  | <i>Following page</i> |
|--|-----------------------|
| 1 Samples showing differential crop growth   | 14                    |
| 2a A crop-mark seen from eye-level near Eynsham, Oxon.   | 14                    |
| 2b The ditch underlying a crop-mark near Stanton Harcourt, Oxon.   | 14                    |
| 3 Romano-British enclosure near Hassingham, Norfolk  | 22                    |
| 4a Circular enclosure of 'henge' type near Stratford St. Mary, Suffolk   | 22                    |
| 4b Buried Roman roads in Normangate Field near Castor, Northants   | 22                    |
| 5 Soil-marks in course of formation  | 22                    |
| 6 Ancient terraced fields N.E. of Glyphada, near Athens  | 22                    |
| 7 Ancient fields and road N. of Glyphada   | 30                    |
| 8 Ancient fields E. of Trachones, near Athens  | 30                    |
| 9-10 Ground photos of remains near Trachones and Glyphada  | 30                    |
| 11 Enclosures adjoining Dunluce Castle, Antrim, N. Ireland   | 46                    |
| 12 South Germany, former trackways and fields revealed by snow   | 46                    |
| 13 Old and new field-systems west of Salonika  | 46                    |
| 14 Sources of error: a comparison of the marks produced by an ancient road and natural features, south of Veii | 46                    |
| 15a Marks produced by natural features in Apulia   | 62                    |
| 15b Stereogram, for the interpretation of natural markings   | 62                    |
| 16 A pocket stereoscope in position for use: view of Erbil, North Iraq   | 62                    |
| 17-18 The value of the oblique air view: Samarra, and a Roman road in N.W. Iraq                                | 62                    |
| 19 Vertical plan-view of Nimrud, Iraq  | 70                    |
| 20 The site of Tchoga Zembil, S.W. Persia  | 70                    |
| 21 Oblique view of Gordion, W. Anatolia  | 70                    |
| 22-23 Tumuli near Gordion  | 70, 78                |
| 24 The city of Hatra and its environs, N. Iraq   | 78                    |
| 25 Neolithic settlement and other crop-marks 8 miles N.E. of Foggia  | 102                   |
| 26 Neolithic settlement near Foggia, Apulia  | 102                   |



|  | <i>Following page</i> |
|--|-----------------------|
| 27 Neolithic settlement 12 miles S.W. of Manfredonia, Apulia   | 102                   |
| 28 Site of Neolithic village 4 miles S. of Foggia  | 102                   |
| 29 Excavated Etruscan tumuli in the Banditaccia cemetery at Cerveteri  | 110                   |
| 30 The Banditaccia cemetery, showing sites of levelled tumuli discovered from the air  | 110                   |
| 31a Enlargement, showing details of buried entrances to tumuli   | 126                   |
| 31b Ground photo of the same area, when no traces were visible at eye-level  | 126                   |
| 32a Remains of the tumulus mound above the Tomba Moretti, in the Banditaccia cemetery  | 126                   |
| 32b An example of a soil-mark revealing the outlines of a levelled tumulus; Colle Pantano cemetery   | 126                   |
| 33a, b Levelled tumuli found in the Etruscan cemetery at Colle Pantano, illustrating the value of comparing air photos taken in successive years | 134                   |
| 34 The Etruscan cemetery on Monte Abetone at Cerveteri, showing tumuli found from the air  | 134                   |
| 35 Ground photos of the Monte Abetone cemetery   | 134                   |
| 36 The Monterozzi cemetery at Tarquinia showing levelled tumuli mapped from the air  | 134                   |
| 37 Monterozzi: enlargement, showing the zone round Secondi Archi   | 142                   |
| 38 System of Roman centuriation at Cesena, Po Valley   | 158                   |
| 39 The junction of two systems, round <i>Patavium</i> (Padua) and <i>Altinum</i>   | 158                   |
| 40 Centuriation near Pola in Istria  | 158                   |
| 41 Roman field boundaries in the same system, on the west side of the Arsa Channel   | 158                   |
| 42 Zara ( <i>Colonia Iader</i> ) in Dalmatia   | 174                   |
| 43 Another view of the <i>centuriae</i> discovered from the air, south of the town   | 174                   |
| 44 The site of Diocletian's Palace at Split and adjacent centuriation  | 174                   |
| 45 Part of the centuriation found between Split and the site of Salona   | 174                   |
| 46 Remains of <i>limitatio</i> at Trogir, west of Split  | 190                   |
| 47 Part of the zone of ancient gridded roads found on Hvar island, off the Dalmatian coast south of Split  | 190                   |

|        |  |     |
|--------|--|-----|
| 48     | A unit of 20×20 <i>actus</i> at La Marsa, on the Carthage peninsula                  | 190 |
| 49a, b | Central Tunisia: subdivisions in the coastal centuriation between Chebba and El Djem | 190 |
| 50     | Valence, Rhône Valley  | 206 |
| 51     | Traces of centuriation S.E. of Valence   | 206 |
| 52     | Buried streets found from the air in the city of Paestum                             | 206 |
| 53a, b | Ground photos of remains   | 206 |
| 54     | The site of the town and silted port of Cosa, 85 miles N.W. of Rome                  | 222 |
| 55     | Enlargement, to show the Roman channels cut to keep the harbour clear of sand        | 222 |
| 56     | Carthage: the Punic and Roman harbours and coastal structures                        | 222 |
| 57     | Ostia: the mouth of the Tiber  | 222 |
| 58     | Ostia: the street-plan   | 230 |
| 59     | Ostia: Piana Bella and Isola Sacra   | 230 |
| 60     | Ostia: the harbours of Claudius and Trajan   | 230 |
| 61     | Ground photos illustrating ancient topography at Ostia                               | 230 |
| 62     | Verona and the ancient course of the Adige   | 238 |
| 63     | Piacenza: the Roman street-plan  | 238 |
| 64     | Pavia: the Roman street-plan   | 238 |
| 65a, b | Castelfranco Veneto and Cittadella: examples of medieval town-planning               | 238 |
| 66     | Le Motte: plan view from the air   | 254 |
| 67a, b | Ground photos of the earthworks  | 254 |
| 68     | Palmanova, N.E. Italy  | 254 |
| 69     | The site of Gergovia, Auvergne   | 254 |
| 70     | Carcassonne: the Cité and Bourg  | 262 |
| 71     | Ragusa (Dubrovnik), Dalmatia   | 262 |
| 72     | Delos  | 270 |
| 73     | Rhodes: the site of the Classical city   | 270 |
| 74-75  | Rhodes: ground photos of archaeological features                                     | 278 |





## CHAPTER I

# AIR ARCHAEOLOGY: ITS PURPOSE AND PRACTICE

*Principles and Objectives 1, Use of the Evidence: Introduction 11, Vegetation Markings: Crop Sites 13, Grass and Weed Marks 24, Soil-Marks 27, Shadow Sites 34, Special Types of Site 41, Terrain Study 44, Sources of Error 47, Method, (a) Obliques 49; (b) Photographic Apparatus 54; (c) Air Crew 56; (d) Verticals: Calculation and Choice of Scales 57; (e) Stereoscopy 59; (f) Ground-Air Survey 63, The Plan View: Selected Sites (Nimrud, Tchoga Zembil, Gordion, Hatra) 66, Scope and Limitations of Search 75, Conclusion 82.*

IN PRINCIPLE, the archaeological study of air photographs contains elements of a good academic discipline;<sup>1</sup> for, to be successful, the work *must* combine the particular and the general. On the one hand, scrupulous attention must be given to the analysis of details, extending it to the smallest which often prove to be of prime importance;—while, on the other, the results of such study usually involve some appraisal of the past history and character of entire regions, in terms of such major problems of the Ancient World as Roman colonial settlement, the evolution of town-planning, prehistoric agriculture, or the distribution of specific types of site. But topographical discovery does not work in a vacuum: it must be made to pull its full weight in unison with other branches of research, in close liaison with the work of modern historians and the study of ancient sources (e.g. of Roman writers on agriculture). Clearly, this link must be made one of the strongest in the chain, conjoined to ties with geographers and geologists.

Although air photography is now an accredited, almost a veteran, aspect of archaeological method, there is still much to be done in ensuring that its practice, potentialities and limitations are widely and fully understood, especially in the many countries in which it has not yet been applied systematically as it has in Britain.

I shall come at once to the purpose and structure of this book. The primary emphasis is placed on Mediterranean countries which offer wide scope for

<sup>1</sup> In what follows I am thinking of concrete instances of systematic study in recent years (to be mentioned later), and in terms of the scale of effort now obtaining. Aerial surveys comprising thousands, sometimes tens of thousands, of vertical photographs (which are pictorial plans) are now comparatively commonplace. Even when taken for other purposes, they can often serve archaeology as a valuable 'intelligence' source.

aerial discovery, although, until recently, some were almost virgin ground from the view-point of this technique. As far as possible I have selected sites known to me personally; the majority of the photographs are unpublished, while the remainder have only made a preliminary appearance in periodical journals. This introductory chapter deals with essential matters of method, the indispensable prelude to the study ('interpretation') of the evidence from the photos. In the following chapters separate subjects are analysed. In these, I have given first choice to large well-preserved sites, or to groups of related sites, of major importance,—concentrating mainly on new discoveries of fact.

The significance of the photographic data does not end only in the 'tactical' amassing of new sites or in amplifying the plans of old ones. That is only one consideration, important though it is. Of greater consequence is the comprehensiveness that is often attainable, which opens the way to our broad 'strategic' assessments of regions and problems in periods when civilisation was younger.

There, perhaps, is the chief point that I wish to stress in this book. A quantitative increase in data, in sufficient force and localised, can produce a qualitative change. The ultimate aim of archaeology is the overall picture of a human community, its economy and setting,—societies as 'going concerns'. And if we can show the topography of entire road-networks, or agricultural systems, or cognate settlements by dozens as neighbours, then each assemblage becomes more than the sum of the many parts,—it is a long way towards the organic whole. In the same way it is a maxim that 'cultures' (in the archaeological sense) are best considered as the sum of their constituents, material and spiritual, and not by taking this or that element as representative of the total. The determination to enquire, and to show, how a site, a group of communities, or even a region, *functioned as a living entity* is a positive fundamental. In order to give it reality the facts must be made as complete as possible,—and first of all the topographical data.

The examples of 'ancient landscapes' here chosen, range in size from individual sites to areas of many square miles which show visible traces of being archaeological unities. A requisite qualification for inclusion has been that the original lay-out should survive, at least in skeleton plan, to a reasonable degree of completeness. Every landscape exists, as it were, on several planes; there are man-made features and there is the setting supplied by Nature. They can be re-divided but together combine to form a 'whole-scape.' Let us translate this into more practical terms, when 'air-plus-ground' archaeology works as a combined operation. In dealing, say, with the site of an abandoned medieval village, equal attention should be given to locating and mapping the remains of all the ancillary features,—its fields and trackways, kilns or fish-ponds, the minor things which 'make life go round' in a small community. And then, exploiting to the full the all-embracing, pictorial qualities of aerial survey, one can examine the way in which human energies made use of the solid natural background,—such resources as water-meadows, forest, waste, mountain



grazing for transhumance, etc. Some impression of this can be got from large-scale maps if of good quality, but not, I think, a visual record of equal force. It is not simple to communicate the resulting effect to those who have not worked in this way:—to do so would often entail the publication of a large 'mosaic' of photographs covering a wide area, which is easier to prepare than to print.

True, the concept of 'ancient landscapes' as organic topographical wholes is familiar in diverse ways throughout an intellectual spectrum ranging from geology at one end to poetry at the other. The archaeological view comes midway between the poles of experimental science and humanism, receiving from both; from that central position the exploration of the idea can be developed in countless ways. The pictures in our exhibition start with the slow-motion epics of palaeolithic ages, in which Man is barely visible as a puny fellow-traveller among the species, the very sport and plaything of changes in land and sea. Further along are the landscapes in Heroic and Classical styles, with Man increasingly dominant; and we end with the archaeology of the Recent Past which already provides archaic cultural landscapes requiring careful study. Among these last, a minor 'work' of interest is the physiognomy of the English landscape during the enclosure movements. Using field-work and direct observation of its traces to supplement the historical sources, Dr. Hoskins has enabled us to visualise the raw original (since blurred by time), creating a sharpness of natural detail that brings to mind paintings of the Dutch School. Archaeological eyes have even begun to examine the somewhat prosaic but extensive remains of the all-but-defunct British 'Canal Age,' with its hey-day of building in the last years of the 18th and early years of the 19th centuries. The landscape at our door often contains some remnants of this *nature morte*; desiccated waterways that are now 'travelling earthworks', with red-brick bridges, tunnels, isolated cottages and overgrown landing-stages, all moribund and marooned high and dry.

Marc Bloch has compared the landscape of the present day to the last exposure in a continuous strip of film. This analogy retains the two vital facts:—continuous change proceeding in details, and sequences of overall changes. But the essence of a film is that it is animated. To recover some of the *animation* of life from dead landscapes, over and above the static plans, is the most exacting and subtle task in archaeology. The approaches are various and combined; pre-eminent is the mastery of excavation technique, and in this Sir Mortimer Wheeler's *Archaeology from the Earth* goes to the heart of the matter. Another approach is the comparative study of ecological zones and technologies, as practised so notably by Professor Grahame Clark in his *Prehistoric Europe: the Economic Basis*; and complementary to this is the systematic preparation and analysis of distribution maps, exemplified by Sir Cyril Fox's survey *The Personality of Britain*.

Common to all these approaches is an ultimate desire to explore thoroughly *complete* social units, advancing from single sites to regions; keeping and extend-



ing archaeology's hold on scientific methods, while attempting to give its conclusions the depth and intimacy which come from good historical sources, plus some sense of that factual 'knowledge' of a people which we all acquire habitually in the daily observation of a living society.

To hasten and implement that end, air reconnaissance should be harnessed to archaeological policy with still more deliberate purpose. For revealing the distribution of certain types of site, it can be a more effective method than any other known; and 'distribution is a necessary prelude to generalisation', in the words of General Pitt Rivers. The comprehensiveness of the topographical data given by air photography on the widely differing types of ancient landscapes shown in the following chapters helps us to put this dictum into effect. Such data can likewise give us firmer ground on which to deal with population problems, whose importance to our understanding of past societies was lately urged again by Sir Mortimer Wheeler. 'Indeed', he adds, 'if I were asked to name one problem more than another which demands investigation during the next thirty years, whether here or abroad, I should say, "the problem of numbers". . . . No light task for the archaeologist, but an essential one if we are to transform dry bones into something approaching live social history' (*op. cit.*, 216).

It is a truism that aerial mapping can telescope years of work on foot into the span of weeks. In many quarters, exhortation on this score is already needless. In our own country, the late Major Allen's flights<sup>1</sup> over the Cambridgeshire Fens and the Oxfordshire gravel terraces, or Dr. St. Joseph's over Roman Scotland and in quest of deserted medieval villages, have accustomed us to discoveries in quantities. But in Mediterranean lands the superimposition of ancient civilisations was on a scale far greater than our remote islands ever witnessed. In Apulia in southern Italy, for example, the dense and intricate markings of buried sites produced a complex picture which, when mapped, resembles a much-used blotting-pad many square miles in size! Three separate cultural landscapes of different periods could be re-created. On the margins of the Mediterranean world, Père Poidebard, M. Saumagne, Colonel Baradez and Mr. Goodchild have each made contributions of the highest importance to the aerial mapping of extensive Roman landscapes, mainly from surface-remains in desert or semi-desert regions. But, although these results are well-known, it is probably true that the potentialities of air archaeology for other important areas still need to be made clear.

<sup>1</sup> A rough draft of a book which he had begun, describing some of his discoveries, was found among Major Allen's papers posthumously, and thanks to the good offices of Dr. Crawford the MS. was put into preliminary form. A great deal of additional work was still needed, especially as the book needed to be enlarged into the form of a final account and reference volume, and the present writer undertook this task. Full descriptions of the plates had to be written and confirmed by field-work, and site-plans drawn. The illustrations form a corpus of permanent value; some give the only comprehensive pictorial plan of major sites in the Oxford region which have since been completely destroyed by gravel digging. In the last few years many of the sites which Allen found have been dated by excavation, greatly to the benefit of the descriptions that can now be given of his discoveries.

This volume, entitled *Discovery from the Air*, is cited below; it will go to press in 1957.



One point to be emphasised is that the methods of discovering 'buried' sites used in Britain over many years operate effectively in Mediterranean lands, under appropriate conditions. In Italy, for example, we now have a body of 'crop-mark' and 'soil-mark' sites whose existence and appearance rest on exactly the same principles as are valid in North-west Europe. And they undoubtedly exist, though scarcely recognised, in Greece, Spain and other intensively cultivated countries. An assurance of this fact is an important gain in knowledge. For the addition of *buried* sites opens the way to whole new categories of discovery—a vital supplement to the remains exposed on the surface which are more obvious.

It is possible, then, that we are on the threshold of a new and fruitful era of discovery in and round the heart of the Classical World, if this form of research is systematically and understandingly employed. The discoveries so far made give encouraging signs of others to come. And it is an often-repeated experience in archaeology that sites whose name and fame have long been known can still yield major discoveries. There are, beyond doubt, many familiar sites in Etruria which will exemplify this in the future. There is hope also for regions of whose early history we know little, e.g. the lowland coastal areas of Sardinia endowed with favourable expanses of corn and grass.

I must stress, however, that it would be fallacious to expect every region to provide aerial discoveries. In some they are virtually excluded by the terrain, modern method of cultivation, etc. But in the Mediterranean there is no doubt as to three countries that are now of cardinal importance for air archaeology:—Turkey, Greece and Spain. We must hope that the beginnings made in each can be broadened into systematic programmes.<sup>1</sup> Foremost of these is probably Turkey; the coast and interior plains of Anatolia could yield a great wealth of sites, capable of having a crucial bearing on the archaeology of many lands to the west. In these three countries there would be no question of an aimless search, for there are clear indications already.<sup>2</sup> All three contain regions of similar ecology to those in Italy which, as will be shown, have given notable results from aerial investigations.

Italy, naturally, also comes high in the list. Here we can look to the future with expectation. My own study, based on war-time photos, has extended to almost every region of archaeological importance. Following this, plans are being made (at the moment of writing) by the Lerici Foundation in Milan, in conjunction with the authorities in Rome and Florence, for systematic programmes of archaeological air survey,—in the preparation of which I am glad to have been able to assist. We may hope that this wise Italian initiative will be crowned with success. The sites of certain Etruscan towns and the traces

<sup>1</sup> Vertical survey of key localities is the ideal method, supplemented by oblique photos where required by the type of site. The first essential is a scheme of priorities for regions and problems to be investigated, spreading the reconnaissance over a few successive years. Careful planning, on principles indicated below, will ensure economy of effort.

<sup>2</sup> Cp. discussion on pages 70, 30 and 76; also Plates 6-10 and 21-3.



of roads radiating from them should prove interesting subjects.<sup>1</sup> Naturally, a good deal of vital 'staff-work' must be done before the aeroplane even leaves the ground. Success depends, to a very large degree, on selecting sites and areas of a suitable kind (and favourable conditions of soil and vegetation), besides choosing the correct weeks in the year (and the time of day) when photography will be capable of recording the evidence.

We may return for a moment to the structure of this book. Some famous sites are like well-known works of art; the composition is there for all to see, but it can be approached from a new point of view. This is especially true of the plans of ancient cities, in which the phases of growth can be graphically seen and demonstrated afresh in the vertical aerial view. I have included several photographs of this nature, at the risk of wearying the specialist with explanatory comment. Nevertheless an expert on Carthage, let us say, may be glad of a summary of the position at Ostia; and this book is intended to serve both specialists and non-specialists in the subjects discussed. It is hoped that technical jargon has been rooted out, apart from a few terms which are explained.

Perhaps I have harped too insistently on the virtues of this branch of archaeology. To protest too much was always an unsuitable way to earn belief. At the same time it must be remembered that methods long practised in some countries require explanation in others. And severe limitations in the usefulness of the technique have equally been made plain; a number of them are described on p. 75, and other caveats are mentioned elsewhere. Photographic discovery and interpretation is, as I have emphasised throughout, essentially a guide and mentor, and can never replace excavation and ground reconnaissance. Having said this, however, it is perhaps necessary to add that there are limits to useful caution. There is sometimes a feeling, perhaps sub-conscious, that those visible traces which are characteristic of certain types of 'buried' sites are not tangible, but belong to a limbo of the un-proven. This is unnecessarily over-cautious, for the body of experimental proofs is now extensive and sure. By analogy, there are many appearances on X-ray photographs that are clinically diagnostic, without requiring confirmation by surgery through tissue and bone to the deep-seated cause. Often it is *not* the 'buried' sites, made visible by markings above them, which take most time to consider; but, instead, the ancient features (e.g. of roads and boundaries) still surviving above ground and incorporated into existing boundaries in the living landscape.

As the range of subject matter must be both wide and detailed, the reader may find it convenient to have, at the start, a *résumé* of some of the chief points from those discoveries that will find mention in this book.

First perhaps should be placed those which have mapped about 2,000 levelled Etruscan tumuli and have provided detailed maps of famous cemeteries (Chapter III); others have brought to light the ancient street-plans of Paestum (p. 218 seq.) and Rhodes (p. 277 seq.), and helped to clarify the environs of

<sup>1</sup> For buried roads in Central Italy, see p. 77.



Ostia (p. 237 seq.). Of the discovery of widespread systems of Roman land-settlement at Salona (p. 183), at Zara and on Uljan (p. 178), on Hvar (p. 191), and at Valence (p. 207), I need only to say at the moment that this was the first time that these chess-board landscapes had been mapped either in Dalmatia or in Gaul. Additions have also been made to systems of this kind recorded at Pola (p. 175), Aquileia (p. 172), Cesena (p. 156) and elsewhere. Chapter II gives a retrospective glance at the techniques we used when locating ancient landscapes in Apulia in 1945: the great corpus of sites discovered is reserved for another publication. True, we had unusual resources in 1945, but the vital point (as far as this book is concerned) is to show that success does not depend on luck, but on *valid general principles*, e.g. on crop-markings whose value for discovery on a large scale in Southern Europe had not been proved before. Attention may be drawn, too, to problems concerning the remains of old field-systems found at the southern end of Mt. Hymettos (p. 29); and to the examination of off-shore structures in the sea at Carthage (p. 231) and an unusual military earthwork in the Veneto (p. 268). Among finds I have made elsewhere, the following are briefly put on record (p. 75 seq.):—groups of 'ring-ditches' (levelled barrows) in the Somme valley shown by crop-marks; the buried road-system round Vulci in Central Italy; markings in Sicily resembling those made by Neolithic sites on the Tavoliere in Apulia; and additional traces of Iron Age field-systems in Denmark. There has also been time for a good deal of work on sites in England, including reconnaissance flights. Plates 3-4a show two of the sites which I found and photographed some years ago, having chartered an aircraft from Eagle Air Photos Ltd., in order to test for myself the possibilities for aerial discoveries in East Anglia. I am grateful to all those who piloted me on these sorties, particularly to Mr. Keith Jopp, one of whose discoveries is illustrated on Plate 4b.

There is nothing mysterious about the methods by which aerial discoveries are made,<sup>1</sup> but to make them, to map them, to evaluate their archaeological significance, and to follow them up with work on the ground, calls for a sustained effort, which in the case of big surveys will take several years to complete. In giving this book its title I sought to emphasise that what matters fundamentally is, in a word, the *use* we make of the new information, to restore a picture of life-like communities. I again stress these ends before passing to a necessarily detailed summary of the means, lest the archaeologist's tasks as discussed in the next few pages should seem to turn him into a mere technician. On the contrary, such regional studies as those by Poidebard and Baradez abroad, or those within the ambit of British archaeology<sup>2</sup>, have shown the full extent to which air

<sup>1</sup> Specific accounts in the last decade include: D. N. Riley, 'The technique of Air Archaeology', in *Arch. Journ.*, 1944, 1; J. K. St. Joseph, 'Air Photography and Archaeology', in *Geogr. Journ.*, Jan. 1945, 47; P. Chombart de Lauwe, *Photographies Aériennes*, 1951; J. S. P. Bradford, 'Progress in Air Archaeology', in *Discovery*, June 1952, 177.

<sup>2</sup> E.g. 'Air Reconnaissance of North Britain' by J. K. St. Joseph, *Journ. Roman Studies*, 1951, 52-65, describing the discovery of numerous forts and camps which illustrate the Roman conquest of Lowland



photographs may properly be used as pictorial 'sources,' for the study of problems in history and pre-history. When systematically taken and studied, and administered as a library, they constitute a unique form of public record; and the data drawn from them take rank with all the other conventional forms of archaeological evidence. That these facts are recorded from the *air*, by means still partly novel, is a minor matter compared with what the facts tell; on the other hand, to minimise the true element of the dramatic that is inherent in their discovery would be doing a disservice to archaeology.

There is no need to linger over the evolution of air photography. The history of its archaeological use has been well summarised by Dr. G. E. Daniel;<sup>1</sup> the techniques have come largely by way of modern warfare, with methods adapted and given new impetus by individual initiative. But in essence air-archaeology is only the continuation of field-archaeology by other means,—in Britain, the latest extension of our tradition of the practical study of antiquities in remote parts of the countryside, which has continued strongly ever since the tours of Leland and others in the 16th century. Moreover we have been uniquely fortunate in having the assurance of the constant interest and good will of the Royal Air Force and a vigorous lead from the Ordnance Survey. By now it has become axiomatic in this country to consult air photographs at the start of any systematic field-work.

Since the last War this has been facilitated by the rapid annual growth of the Air Ministry's National Survey, which consists of vertical photos at 1 : 10,000 scale (about 6 inches to the mile). The limitations and merits of the Survey, archaeologically speaking, have been clearly set forth by Steer.<sup>2</sup> Obviously, its value from this standpoint is lessened by the fact that the times and seasons of photography were often unsuited to our specialised requirements, but this is far from being the whole story. To the appropriate classes of site such photos have much to contribute. Steer mentions that he discovered, in the course of a few hours' examination of the prints, no less than four prehistoric forts and thirty-two homesteads in two Roxburghshire parishes, which otherwise would still be unrecorded. The National Survey photographs have proved of outstanding value in the studies of Iron Age and Romano-British field-systems by

Scotland; 'Air Reconnaissance of South Britain', *J.R.S.*, 1953, 81-97. Also P. P. Rhodes, *Oxoniensia*, XV, 1950, 1-28, on 'The Celtic Field Systems of the Berkshire Downs', and M. Beresford, *The Lost Medieval Villages of England*, 1954; in both of these important studies of ancient landscapes air photographic evidence played a leading part. To these should be added two regional syntheses:—D. N. Riley, in *Oxoniensia*, VIII-IX, 1943-44, 64-101, 'Archaeology from the Air in the Upper Thames Valley'; *idem*, *Antiquity*, 1945, 145 seq., 'Aerial Reconnaissance of the Fen Basin' (with its sequel, *ibid.*, 1946, 150 seq.); Riley notes that the number of single ring-ditches and levelled tumulus-circles in the Upper Thames valley now totals at least 400. This entire distribution has been put on record by air reconnaissances. For a summary of St. Joseph's discoveries see *J.R.S.*, 1955, 82-91, 'Air Reconnaissance in Britain 1951-55'; also in *Recent Archaeological Excavations in Britain*, ed. Bruce-Mitford, 1956, pls. XLVI-LII.

<sup>1</sup> *A Hundred Years of Archaeology*, 1950, 294-302; cf. also *Découverte Aérienne du Monde*, 1948, ed. Chombart de Lauwe; and O. G. S. Crawford on 'A Century of Air Photography', *Antiquity*, 1954, 206-10.

<sup>2</sup> *Antiquity*, 1947, 50-3. Prints may be purchased, e.g. through the Council for British Archaeology.



Rhodes, Atkinson and others, and equally in the mapping of medieval village sites by Beresford and other members of the Deserted Medieval Village Research Group (p. 36). They are also methodically used in briefing the field investigators from the department of the Archaeology Officer, Ordnance Survey. The advantages that come from stereoscopy substantially increase the archaeological usefulness of this vast body of prints. In the first place the scale is doubled, in practice, to 1 : 5000 or better by the use of a stereoscope (p. 59 and Plate 16), and the examination of the terrain in relief opens a new world to those who have habitually studied single photographs. Meanwhile, in the last decade, the nucleus of a collection of prints for archaeological study has taken shape in several British universities, and at Cambridge the post of Curator in Aerial Photography has been created. Dr. St. Joseph's annual seasons of reconnaissance, based on facilities given by the Air Ministry, continue to produce a never-ending series of finds, not least, be it noted, in regions which have been elaborately explored on the ground.

But discovery *per se* is not the end of the matter. No less important are two requisites on which it depends for its fulfilment:—(a) the ready availability of the evidence in organised libraries,<sup>1</sup> (b) the form in which this is published. Another instance of (a), a library of air photos which can be consulted by research workers, is the *photothèque* established by the Institut Géographique National in Paris. British archaeologists have set a good example by making photographs available for study by others,<sup>2</sup> and during the last few years representative selections have been sent by several bodies in this country for exhibition in cities of western Europe. Today, every nation uses air photographs that are fundamentally alike,—there should be no impediments to their use if provisions safeguarding security and copyright are applied with common sense. Up and down the world, many areas of archaeological interest (too numerous to list here) have been photographed by commercial air survey companies since the 1920's, and vast regions have recently been covered for our own Directorate of Colonial Survey, which has its own print library. The archaeologist may often have to spend many hours in search before he can extract gold from such ore,—but, on the other hand, he may save himself weeks of work in the field later and great expense far from his base. A map of world air photo coverage has already been published (p. 79).

All these prints from diverse sources now number millions, and it is plainly impossible to re-examine each one. In any case, many are of too small a photo-

<sup>1</sup> The method of reference to continuous series of vertical photos is more or less standardised. The exact area covered by each successive print taken on a flight ('sortie') is plotted on a map, or, if photography is extensive and repeated, on transparent overlays above maps (cf. specimens illustrated in Chombart de Lauwe's *Photographies Aériennes*, etc.). The latter method ensures accurate reference to comparative photos of different dates—often a factor of great importance. Single obliques and verticals can be indexed by sites.

<sup>2</sup> Cp. A. Stieran, 'Englische Luftaufnahmen in Nordwestdeutschland und römische Forschung', *Germania*, 29, 1951, 72-5, referring to facilities given to Prof. Kahrstedt in 1949 for the study of certain British air photographs covering the sites of Roman camps in N.W. Germany.



graphic scale to be of much use archaeologically, but it would be a grave mistake not to make full use of the large residue, which often cover little-known areas where the possibility of flights planned specifically for archaeology is very remote. It was, for example, a single photographic sortie made when surveying the ground for a dam which first enabled Colonel Baradez to prepare a detailed map of part of the Roman frontier defences in Algeria. From only 120 vertical stereoprints, he was able to map an area of 15,000 hectares, packed with discoveries. Nor is this an isolated example.

The increased scope of discovery makes effective publication a matter of growing importance. The evidence must, in its very nature, be presented by (and judged from) a *liberal* supply of good illustrations, large in size: the best are from half-tone blocks carefully prepared with fine screens (i.e. 130-line to 150-line screens), printed on glossy paper of a suitable kind. Photogravure on a semi-matt paper can produce very sharp printings of air photos (cp. the *Illustrated London News*). This process uses a very fluid ink. Care must be taken with the details in the darker parts of the print. Whatever process is used, final success depends largely on skilful inking by the printer; in no branch of archaeological illustration is the quality of reproduction of greater importance. But in drawing the interpretative plans the onus of clarity rests with the archaeologist. The first maxim is: always err on the side of caution. It is as vital to know what to leave out as what to include; one must remember that the vast majority of the markings and features seen in most landscapes are non-archaeological (p. 47, 'Sources of error'). The second maxim is: the better the fieldwork on foot the better the interpretation of the photographs. Often it is helpful if they are re-examined after an interval, with a fresh mind and eye. Where the archaeological details are very numerous, as in the remains of Roman agriculture or Etruscan cemeteries, some *minutiae* have to be omitted for the sake of clarity; such selection and emphasis require careful judgement. If the photographic details are not distinct, diagrams on transparent overlays are useful. Annotation direct on to the photos is an economy to be used sparingly, and only when there is no danger of obscuring significant features. In the final stage of a major study, when the evidence seems complete for the present, the massed results of ground-air data are best shown collectively, overprinted in colours on a base map of some paler tone (preferably in red or black on a grey base). The intrinsic need for so much illustration makes original monographs costly, and is a limiting factor for journals although some (notably *Antiquity*) have provided generously within their means. In the outcome, the tendency for the rate of discovery to outstrip the rate of quick and regular publication has become an undeniable and regretted problem. Yet the need is undoubtedly for more air archaeology not less, particularly for the planned reconnaissances whose preparation this book is intended to assist.



## USE OF THE EVIDENCE: INTRODUCTION

Whatever the form of the photographic or visual record from the air, the *end* is to make it an instrument of purposeful archaeological policies; the *means* lies in a clear understanding of what evidence to look for and how to find it. These practical matters form the substance of the book, and, briefly, they will be treated as follows. We start by defining the uses of the evidence, and go on to consider in detail the classes of site that provide it (p. 13), methods of obtaining and using it (p. 49), and its capabilities in general. In the succeeding chapters, the first two deal specifically with the recovery of the evidence of sites that lie *below* ground, and the last two concentrate on the study of remains *above* ground.

The oblique photograph has all the expository advantages of the view from a conveniently portable hill-top and from a hand-picked position at close quarters. The vertical has a prime importance as map-maker. They are not rivals but complementary, each with its proper functions. The essential advantage of the vertical view is that measurements of sites can be made directly from it, and examples are given below (p. 58) of the high degree of accuracy that can be obtained. With practice, such calculations should take only a minute or two (p. 143). A series of overlapping verticals confers all the benefit of stereoscopic examination, described in a later section (p. 59), and some proficiency in this relatively simple technique should be a recognised part of a training in field archaeology. When studied in this way, the entire surface relief (including the slightest earthworks) can be seen in the form of a three-dimensional model, and is magnified in addition. This differs fundamentally from the two-dimensional view given by a single vertical print.<sup>1</sup> The practical value of stereoscopy is of the greatest importance, and numerous instances of this will be mentioned.

A. First is the graphic demonstration of known sites in the context of their surroundings, with a full visual record of their present state. Exposition will be the main purpose; there are few sites from which one cannot draw fresh ideas, on re-examination. All major earthworks were sited with a keen eye to the immediate setting which is integral to them: their characteristics will emerge all the better in a comprehensive view. The plans of existing towns of ancient origin are in the same category (cp. Chapter V), for the cartographer is often compelled to simplify in map-making.

B. Intermediate between the functions of demonstration and of discovery is the topographical study of areas that are known to have some particular significance, e.g. ancient coastlines and ports (Ostia, p. 237) and river beds (the 'Fiume Morto' at Verona, p. 256). Geological and geographical factors enter extensively into the photo interpretation. For other examples see the section on 'Terrain Study' (p. 44). The physiography of a region when seen from the air can give clues as to where sites are likely to be found.

<sup>1</sup> 'The examination of a single photograph for detail is like going about with a shade over one eye'; Prof. C. A. Hart, *Air Photography Applied to Surveying*, p. 26.



Under this heading may be placed the pictorial mapping of traditional landscapes that are disappearing rapidly (cp. Pl. 13, field systems in Macedonia): one example to which I am giving special attention is the remarkable network of medieval sheep-droeways in Apulia, whose known but fast vanishing remains are the best evidence of the workings of the specialised economy of seasonal transhumance which once covered this region and others like it.

C. Discovery of unrecorded remains:—

- (i) Surviving *above ground*: archaeological features *either* (a) incorporated and re-used in the modern landscape but unrecognised (cp. Roman roads and fields in Dalmatia, Chapter IV);—*or* (b) existing as independent earthworks, but previously un-noticed or not understood by observers on the ground.<sup>1</sup> Essentially, discovery on these lines proceeds from 'total' mapping, *à outrance* so to say. It is remarkable how much is waiting to be discovered by the first complete mapping of the smaller details of topography above ground. Precision brings its rewards. The fragmentary remains of an ancient cultivation-system or street-plan may be literally under one's eyes, but remain unrecognised because a sufficiently detailed survey is not available. A good instance of this is given by the surviving traces of a street system at classical Rhodes which I have been able to plan as a connected whole by aerial mapping, adding corroboration from the archaeological data to be seen on the ground (p. 277). *A fortiori*, it is scarcely likely that any other method will be equal to the task of providing the basic inventory of sites above ground which is a first requisite in many regions that are inadequately explored archaeologically (e.g. in parts of Africa).
- (ii) *Buried* features of all kinds, covered by surface soil or even shallow water; inconspicuous, and at times invisible, at eye-level. It is to this category of sites that air archaeology has made the most decisive contribution, for equal results could not be obtained by other means. Here, too, it best fulfils its function as a guide to the excavator. It is, therefore, evidence of this kind that we shall first consider in the following sections.

D. Preservation is a no lesser duty than is discovery. An added function of air survey is to prevent the unwitting destruction of sites and to enable them to be scheduled, or excavated in advance. Air archaeology is by nature impartial, for any survey is likely to reveal sites of several kinds and periods intermixed. Even on the relatively well-charted soil of Etruria, for example, its use is made urgent at this very moment by large schemes of land-improvement (involving

<sup>1</sup> An ideal instance of (b) was the establishing of the course of the Roman road from London to Lewes. This discovery was initiated by air photos over Ashdown Forest, taken at the instance of Mr. Margary in 1929. They revealed the typical small side-ditches (grass-grown, and inconspicuous at eye-level), differentiating them from the winding medieval trackways that were superimposed. Working from this alignment, the road was then traced in opposite directions,—being found in a perfect state of preservation at some points,—and sectors previously disconnected were united. See I. D. Margary, *Roman Ways in the Weald*, 1948, pls. IX-XII; *Antiquity*, 1932, 350; also *Roman Roads in Britain*, vol. i (1955), 55.



deep-ploughing to a depth of several feet for the first time) which bring grave danger to the important sites that are not visible on the surface but lie buried just below ground-level (instances are discussed on p. 124 and p. 141).

Aerial discovery (especially of buried sites) often happens 'blind', without the slightest indication from other sources of information, but more often it is prompted (as will be explained) by clues to the potentialities given by an 'appreciation' based on the nature of the terrain and surface geology, finds from fieldwork, or ancient texts.<sup>1</sup>

A passing mention must be made of two auxiliary techniques used in archaeological prospecting for buried sites which can supplement air archaeology,—where suitable conditions exist. The first of these methods is the *geochemical*. The soil of ancient settlements often contains specially high concentrations of phosphates, from organic refuse; thus the soil of Fostat, early Cairo, has long been taken by local cultivators for use as a fertiliser. Guided by the principle of soil analysis, archaeological investigations were successful in defining sites in Denmark, on the island of Gotland and in Sweden during the 1930's, and in Italy and England too during the last few years. Near Copenhagen, for example, the lost site of the village of Stokkerup was found in this way, by taking 250 soil samples from a depth of 15 to 30 cms. over an area of 30 hectares and analysing them in order to find a high  $P_2O_5$  (phosphorus pentoxide) content. In regions where the vegetation and terrain are unhelpful to air archaeology this method can be used with advantage to sample wide areas: discovery by elimination should result. The second technique is *electrical resistivity* surveying.<sup>2</sup> The electrical conductivity of soils and rocks varies with the amount of moisture they can hold and depends upon their composition: as a result there are differences of electrical resistance. With special instruments (e.g. the 'Megger' Earth Tester) these can be recorded and plotted as a graph, to confirm buried walls or ditches,—and the method is serviceable when the data from air photos or other indications are not sufficiently precise. See p. 144 for the latest results, from Etruria.

### VEGETATION MARKINGS: CROP-SITES

That differential plant-growth and colour contrasts in the soil indicate the presence of sites beneath are, by now, familiar theorems of archaeology. But it was only as lately as the 1920's that O. G. S. Crawford literally put these buried landscapes on the map. True, others had seen and understood something of such phenomena as long ago as the beginning of the 18th century or earlier

<sup>1</sup> A notable instance of the value of combining the evidence from air photos with that from historical sources is the study of the Roman siege-lines at Masada: C. F. C. Hawkes, *Antiquity*, 1929, 195-213 and pls. I-IX.

<sup>2</sup> The latest examples of the successful use of electrical resistivity surveying on buried sites, to assist the effective use of air photos, were given during the recent archaeological prospections in Central Italy by the *Fondazione Lerici*. For the results, from cemeteries at Cerveteri, and at Fabriano near Ancona, see E. Carabelli, 'Ricerche Geofisiche Sperimentali su Antiche Necropoli', *Rivista di Geofisica Applicata*, 1955, fasc. 1-2 (publ. by the *Fondazione Lerici*, Milano).



still.<sup>1</sup> But 200 years had to pass before the causes and effects were first formulated into principles of general application. It should follow, predictably, that what holds good for the downlands of Wessex should also, *mutatis mutandis*, for the prairie grasslands of South America. It does.<sup>2</sup> Of course if matters were really so simple, discovery would decline into a clerkly chore. But things are far otherwise. Nature is capricious; climate, soil, cultivation methods, and other factors produce all kinds of variables.

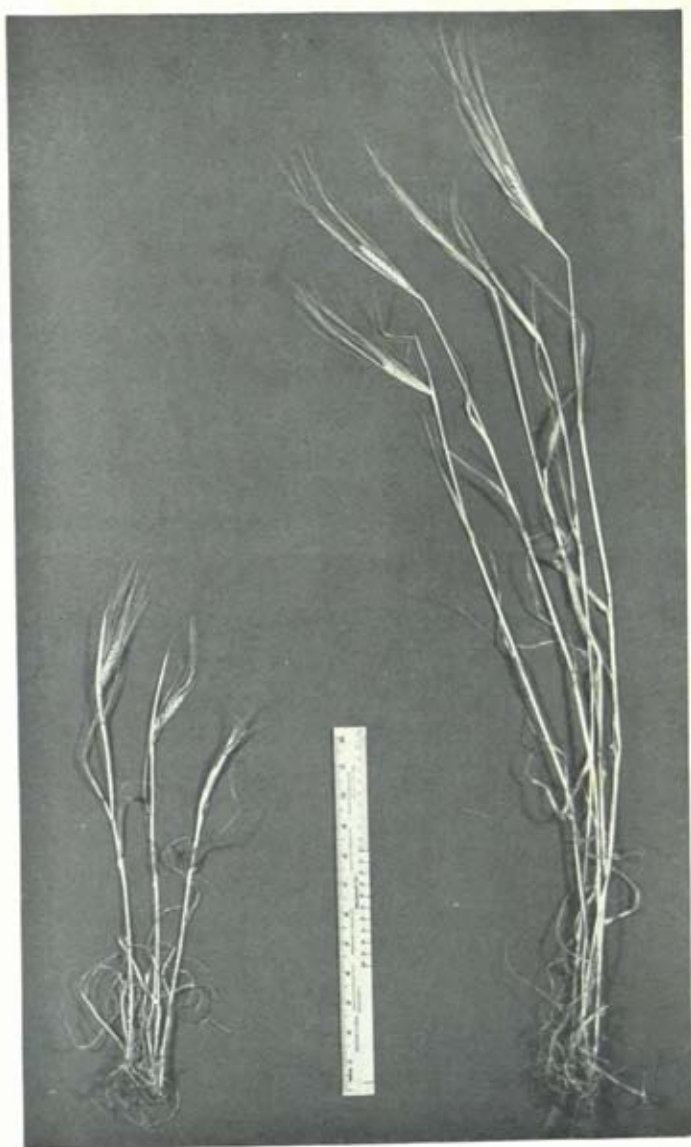
The occurrence of all vegetation markings is geared to weather and season. Thus in central and south Italy, the grain harvest will usually begin about the first week in June; by the beginning of July it will be over, and true crop-markings will have gone. May is therefore the best month in which to act, if ancient landscapes are to be recorded in this form. But weed-markings, hereafter described, can become prominent in the stubble in August and September. In the autumn, the land is revived with a foretaste of spring. Thunderstorms in mid-September and cool days in October regularly bring a welcome green to the bleached ground. This is a second important season for aerial reconnaissance, concentrating on pasture land. But during October ploughing will remove these markings in the stubble-fields. Broadly speaking, equivalent parts of the Mediterranean follow a similar timetable. In north-west Europe conditions are less predictable but June and July are normally the most rewarding months. But a comparative study of Allen's photographs taken annually from 1936-39 proves that strong crop-markings appeared by May in most years,—and young wheat and oats can give excellent results by April. Clover and sugar beet often react best in August and mid-September.

One of the chief controlling factors in the formation of markings by any kind of vegetation is, obviously, the surface geology. In Britain such compact well-drained formations as gravel terraces, chalk, and limestone provide the best conditions, and these subsoils can likewise be relied upon in Europe. It is, for example, on the chalk areas and river gravels of north and north-west France that the first crop sites in that country are now coming to light (p. 75). Hard glacial moraines and sands have been found good in Scotland,<sup>3</sup> and the silt areas

<sup>1</sup> Thomas Hearne in his diaries refers to crop-marks more than once, e.g. under the date 22 May 1714 (Hearne Collections IV (*Oxford Hist. Soc.*, XXXIV, 1897) p. 363) where he describes the streets of Silchester being visible in the growing corn, and under the date 29 Sept. 1722 (*id.* VIII (*O.H.S. L.*, 1907) p. 2) referring to signs of old streets or ways in the cornfields north of Dorchester. Stukeley's knowledge of this principle is clear from a letter he wrote on 12 July 1719, referring to crop marks at Great Chesterford in Essex (cp. Stuart Piggott, *William Stukeley*, p. 52). On the basis of these quotations Hearne has priority, as D. B. Harden points out (*Trans. Newbury Field Club*, 1953, 19, 'Archaeological Air Photography in Britain'), but even Hearne does not claim to be the first to record crop-marks.

<sup>2</sup> Cp. old cattle-trails revealed by crop-markings after the region had been ploughed, round Rosario on the Argentine Pampa; J. L. Rich, *The Face of South America, an aerial traverse*, 1942, pls. 161, 163 and p. 134 (*Am. Geogr. Soc.*, Special Publ. no. 26).

<sup>3</sup> First demonstrated fully by O. G. S. Crawford and Geoffrey Alington during their air reconnaissance of Roman Scotland in June 1939; cp. *Antiquity*, 1939, 280 seq., esp. pl. VA,—a Roman marching camp sited on a ridge of hard glacial sand, its buried ditches revealed by the contrast of bright green with desiccated 'toast-coloured' grass.



1. Contrasted plants taken from a field of barley to show the details of a crop-mark site. On the left: An average plant growing on shallow soil. On the right: A specimen of twice the size, from the same field but growing above the deeper soil provided by a buried Romano-British ditch.

The scale is a one-foot rule. See p. 15.





2a. FOXLEY FARM, EYNHAM, OXFORDSHIRE. A crop-mark seen from eye-level: the position of the ditch of a Bronze Age burial circle was revealed by new growth in a ley crop (clover and grass). See p. 16. *Ph. Bradford, July 1951.*



2b. LINCH HILL, STANTON HARCOURT, OXFORDSHIRE. The underlying cause of one type of crop-mark: the line of dark humus shows the buried ditch of a rectangular Romano-British enclosure, cut into the gravel sub-soil, and exposed after the surface-soil had been removed. As a crop-mark it had already been discovered from the air. See p. 16. *Ph. Bradford.*



of the Fens in eastern England have been equally fruitful. But clay soils are very rarely of any use. In Italy, various kinds of limestone, and also tufa, have given admirable results. Even Roman vine-trenches as narrow as  $1\frac{1}{2}$  feet across will produce vigorous markings. Pits (for burial or grain storage) about 3 feet in diameter are the smallest individual features generally visible from markings in Britain.

Large stake-holes for massive timber uprights can be identified;<sup>1</sup> but buried post-holes and foundation-trenches of wooden huts and houses ordinarily do not affect the vegetation sufficiently to make their appearance; among some exceptions are the timber barrack buildings inside the legionary fortress at Inchtuthill, where green lines in parched grass outlined the positions of the buried foundation-trenches dug for the wooden walls.<sup>2</sup> The site of 'Woodhenge' will serve as an example of the lower limit of what can normally be recorded. Wing Commander Insall was able to see, by direct observation from the air, all the concentric rings of buried stake-holes as crop-marks in wheat in July 1926. On his low oblique (*Antiquity*, I, 92-5) the smallest stake-holes that one can identify with certainty belonged to those which excavation showed were at least  $2\frac{1}{2}$  to 3 ft. in diameter (from  $3\frac{1}{2}$  to  $5\frac{1}{2}$  ft. deep). But many smaller stake-holes were not clearly visible on the photo. The conditions were the optimum, with only 1 foot of earth above the chalk subsoil.

The soft alluviums which form the basis of many important plains in Europe, into which plant roots can easily reach down when conditions are dry, seem to produce vegetational uniformity and to limit the probability of surface markings. This is an important fact.

Let us begin with a simple case which will take us, literally, to the roots of the matter. On the left of Plate 1 is a specimen of barley which I took in April 1950 from a field near Dorchester (Oxon), representative of the normal crop growing in humus only 1 foot deep above the undisturbed gravel subsoil. On the right is a random sample from the same field, and from the same crop, above a buried Romano-British enclosure ditch, estimated to be about 6 feet wide and about 4 feet deep from ground level. From both the air<sup>3</sup> and ground view the contrasts of height, colour and bushy growth between the normal and the favoured plants were clear. Even after harvest, the thicker stalks remaining in the stubble above the buried ditch enable the enclosure's outline to be seen. The plant-chemistry producing vegetation-markings deserves more exact study than it has received. Over this ditch the barley had a much broader blade of darker green, and averaged  $2\frac{1}{2}$  feet in height when examined (it was a dry spring time), as compared with  $1\frac{1}{4}$  feet for the yellowish-green barley elsewhere

<sup>1</sup> E.g. the timber stockades whose long lines of buried stake-holes have been found in south and east England; see p. 18, n. 6.

<sup>2</sup> J. K. St. Joseph, *Journ. Roman Studies*, 1951, 63, and pl. VIII, 2. See also below, 'Scope and Limitations of Search', p. 75, n. 1.

<sup>3</sup> The site can be seen, as a rectangular crop-mark, near the top of an air photo by Major Allen, *Oxoniensia*, vol. III, 1938, pl. XVII; *Discovery from the Air*, pl. 18.



in the field.<sup>1</sup> The former were healthy plants, the latter seemed to be suffering from a phosphate deficiency—which is especially apparent in barley, swedes and turnips. It was a purplish tint on the leaf which betrayed the lack of phosphates. The yellowish-green tint, more noticeable, was caused by insufficient soil-depth, which means *insufficient rooting-depth*, for the roots must feed from *damp* soil. This is the vital factor. Under a hot midday sun, for instance, the crop-roots over a buried ditch will be growing, while the roots over the gravel will only be marking time.

A crop-mark's extra-tall growth can, in extreme cases, even cause a slight shadow and increase the contrast.<sup>2</sup> Occasionally, when long in the stalk and heavy in the head, corn will be beaten down by bad weather and, thus 'laid', will accurately outline a buried ditch.<sup>3</sup> After harvest the mark will persist in the stubble, as the stalks will lie slantingly, reflecting more light. Crop-marks are sometimes obvious at a very early stage in growth, blades of young wheat being well advanced when little has appeared elsewhere on the surface. Another form consists of re-growth in a clover crop (in ley); Plate 2a shows the vivid contrast this can give, even when seen from eye-level. This field (on gravel at Foxley Farm, Eynsham) was photographed in July 1951; its ley crop (mixed rye-grass and red clover) had received a first cutting two weeks earlier. But the clover began to grow again, almost immediately, above the circle of the buried ditch round a levelled Bronze Age barrow.<sup>4</sup> The green band stood out markedly against the cream-coloured stubble of the cut grass-stalks, and some time elapsed before the clover became equally green all over the field. By way of comparison, Plate 2b shows a crop-mark site at Linch Hill, Stanton Harcourt, *after* the shallow humus had been skimmed off to the level of the gravel, exposing the filling of a Romano-British ditch *in situ*.<sup>5</sup> It is not surprising that its deeper soil regularly affected the vegetation above it.

Crop-markings can be found in any European country (p. 75); it is an anomalous and artificial situation that, so far, they have been found in quantities only in Britain, and in Italy (Chapters II and III). Our own soil is revealing

<sup>1</sup> I am grateful to Dr. E. W. Russell, of the Soil Science Department, Department of Agriculture, Oxford University, for kindly reporting on these specimens. A photograph of contrasted samples of corn from a crop-site in Hertfordshire was illustrated by O. G. S. Crawford, in *Proc. Prehist. Soc.*, 1936, pl. XXVIII.

<sup>2</sup> For crop-marks combining shadow and reflected high-light from the taller plants, cp. *Oxoniensis*, 1940, vol. V, pl. XVI (enclosures at Long Wittenham), and vol. XVI, pl. IV (Iron Age storage pits and enclosure, Stanton Harcourt); also *Discovery from the Air*, pl. 48.

<sup>3</sup> E.g. *Victoria County History, Oxon*, vol. I, pl. XXIA (Roman farm nr. Stonesfield), and *Discovery from the Air*, pl. 52b.

<sup>4</sup> For an air photo of these markings, see *Oxoniensis*, VI, 1941, pl. XI and fig. 13 (circle No. V), and *Discovery from the Air*, pl. 5, and also *Luftbild und Vorgeschichte*, 1938, p. 37. This last contains a selection from the best pre-1938 air photos of British and German sites, published by Hansa Luftbild with text by O. G. S. Crawford and E. Ewald. Cited below as *Luftbild*.

When this air photo was taken, early in June 1933, the markings were already clearly defined in fields bearing four different crops:—barley, wheat, oats, and grass.

<sup>5</sup> The appearance of this ditch as a right-angled crop-marking, before gravel digging began, can be seen towards the top of Major Allen's oblique air view; *V.C.H., Oxon.*, vol. I, pl. XIVb.



hundreds more, and I have included two examples of those which I found and photographed during an aerial reconnaissance of the coast and river valleys of East Anglia in July a few years back, using a 5 inch F.L. camera from 1,000 feet. The first of these (Plate 4a), to judge from the photographic evidence, is in all probability a new example of one of the classes of Neolithic to Early Bronze Age ritual enclosures, collectively known as 'Henge-monuments'.<sup>1</sup> On this photo it appears to have a broad continuous ditch and a single entrance. The crop was wheat, and the colour contrast between green and buff was marked. The dimensions can be approximately calculated from the adjacent track, conservatively estimated about 8 feet across. The entrance would be c. 20 feet wide, the ditch c. 20 feet wide, internal diameter c. 75 feet and overall diameter c. 115 feet. On this photo there are no traces visible of holes for timber uprights inside, as at the Arminghall 'henge' site near Norwich (*Proc. Prehist. Soc.*, 1936, pl. I). But the proportions of the inner circle at Arminghall are similar; internal diameter c. 80 feet, and width of ditch c. 28 feet. My site lies in the parish of Stratford St. Mary (Suffolk); its position is just above the 150 foot contour, north of Stratford Hills Farm and close to the south edge of King Wood, which can be seen in the photograph (O.S. New Popular ed., sht. 149, grid. ref. 05203565), in the Stour Valley.

The second example (Plate 3) also has recognisable characteristics. The chief crop-marking is that of a large rectangular enclosure, subdivided by another in one corner. There are some complications from other markings, but there is a clear resemblance to the class of Roman farm-enclosures found from the air by Major Allen round Oxford.<sup>2</sup> This interpretation is strongly supported by Roman pottery which Mr. Rainbird Clark and others have since found on the surface of the field at this point. The enclosure, which at a rough estimate measures about 80 × 150 yards, is situated in Cantley parish (O.S. 1 inch, sht. 126, grid ref. 378054), nine miles ESE. of Norwich and half a mile E. of Hassingham church. Few air photo sites from the parts of East Anglia facing the Continent have yet been published, although the region contains many areas of gravel terraces and other suitable subsoils. Essex, for example, is of interest for its archaeological rôle in relation to immigrant settlers,—and the reconnaissance revealed the existence of crop-sites near the coast.

Air search has, of course, done much to fill some of the artificial blanks in our national distribution maps, as forecasted from the first. In eastern England, the study of prehistoric and Roman landscapes on the Fenland and its margins has been enriched and broadened by the revelation of buried sites, and the quantity of those revealed on the gravel terraces of the upper Thames valley has similarly helped to balance that preponderance which had been attributed to the chalk downs of Wessex because of the number of sites preserved above

<sup>1</sup> For analysis of the types, cp. R. J. C. Atkinson, in *Excavations at Dorchester, Oxon, 1st Report*, 1951; S. Piggott, *Neolithic Cultures of the British Isles*, 1954.

<sup>2</sup> *V.C.H., Oxon*, I, pls. XXI-XXIII.



ground there. The Midlands, too long relegated to the dreary status of a 'lost province', have proved a fruitful hunting-ground for Dr. St. Joseph; so too has Roman Scotland. But as far as published material goes,—and air photos like all documents become fully effective only from their date of publication,—there are regions still insufficiently represented. The Cotswolds<sup>1</sup> are one; so also is the south-west, Somerset, Devon, Cornwall.<sup>2</sup> Potentialities are obvious; the mapping of moorland hut-circles, enclosures and the diverse remains of ancient hill-farming could be greatly aided by the careful study of air photos (for mapping, verticals would be most desirable). The same is perhaps still more true of Wales, and certainly of Northumbria<sup>3</sup> and southern Scotland.<sup>4</sup> The archaeology of highland zones in Britain has usually received less attention, though it completes the lowland picture. Difficulties are real; heather is a hindrance, and so is bracken (though this dies down at regular seasons). But much is bare or under grass, and the dry-stone walling and low earthworks of highlands can make excellent subjects for aerial recording. Specialists on these regions agree that accurate plans have been too few, and they deplore the uncertainties that arise. It would be a great gain if a large comparative series of such sites were published in the form of vertical photographs. In hilly country, it is particularly useful to be able to have a picture of the layout of archaeological features against their natural setting for some distance round. To examples of aerial mapping in these regions I shall return in a future publication, and so must not digress here.

Crop-sites, representing as they do remains which lie hidden, are naturally those most capable of revealing new congeries of sites and of turning isolated instances into significant groups. The ceremonial 'cursus' sites found by Major Allen, and the henge-monuments which he and others added, are examples of such virtually new distributions.<sup>5</sup> Another good example is the class of mysterious 'stockades' produced by Allen and by Riley from the upper Thames valley, Northamptonshire and Lincolnshire.<sup>6</sup> Or, to take a case from Italy,

<sup>1</sup> Major Allen never explored the Cotswolds systematically, but he showed the way by his discovery of a large circle of the 'henge' class at Westwell, near Burford (crop-site); Atkinson, *Oxoniensia*, XIV, 85; *Discovery from the Air*, pl. 13A.

<sup>2</sup> Cp. C. A. R. Radford, *Proc. Prehist. Soc.*, 1952, 55-84, 'Prehistoric Settlements on Dartmoor and the Cornish Moors'; based on ground survey but including two R.A.F. air photos (pl. VI). The long rows of stones in alignment on Dartmoor make another good subject for aerial mapping; see J. Brailsford, *Antiquity*, 1938, 444-463. (Since this plea was written, Lady Aileen Fox has further shown how air photos assist the study of Celtic agriculture on Dartmoor, *P.P.S.*, 1954, 87-102.)

<sup>3</sup> For the types of suitable sites cp. W. J. Hemp and C. A. Gresham, *Antiquity*, 1944, 183 seq. 'Hut-circles in north-west Wales'; A. H. A. Hogg, *Antiquity*, 1943, 136 seq. 'Native Settlements of Northumberland'.

<sup>4</sup> My forecast has been verified by the *R.C.A.M.* volumes for Roxburgh (1956).

<sup>5</sup> As usual, after the type is well defined, examples are then soon recognised in other regions, as for instance with Allen's Neolithic 'cursus' sites; cp. air view of another as a crop-mark at Barnack, Northants; *Proc. Prehist. Soc.*, 1935, pl. XIX. Ground and air reconnaissance has recently made extensive additions to the 'Dorset Cursus' (actually two, joined end to end) measuring six miles long! Cp. Atkinson, *Antiquity*, 1955, 4-9, and pls. I-IV. Cp. aerial plan of cursus at Maxey, Northants, by St. Joseph.

<sup>6</sup> The crop-marks indicate long continuous lines of large post-holes, running across country. For air



there are the trenches of Roman vineyards, which had never before entered field-archaeology as a tangible form of site; yet in Apulia we located their markings in such quantities in 1945 that it has been a major problem to put them on a map.

In contrast to markings caused by extra growth are those from opposite causes,—the reduction or total failure of vegetation above buried roads, wall-foundations, and the hard surfaces of floors, etc., where soil-depth and moisture are consequently less. Grass can react as well as crops. For these effects I use the term 'parch-marks'. Such parching may be severe even in an English summer, and its effects were sufficiently obvious to attract the notice of many early antiquarians. It would be a pity to omit those naive but apt verses turned by John Kenyon, philanthropist and poetaster (1784-1856), on the subject of Silchester's buried street-plan:—

Yet eyes instructed, as along they pass,  
May learn from crossing lines of stunted grass  
And stunted wheatstems that refuse to grow,  
What intersecting causeways sleep below.  
And ploughshare, deeplier delving on its path,  
Will oft break in on pavement quaint or bath;  
Or flax-haired little one, from neighbouring cot,  
Will hap on rusted coin, she knows not what;  
'Bout which though grave collectors make great stir  
Some pretty pebble found had more contented her.

Silchester's street-plan was magnificently shown in the form of parch-markings in June 1934 when photographed from the air by Major Allen.<sup>1</sup>

This was, in fact, some years after an R.A.F. photograph had conclusively demonstrated the importance of parch-marks on urban sites by revealing the plan of the Roman town at Caistor in Norfolk,<sup>2</sup> complete in its essentials and even indicating for future excavators the probable outlines of the forum, temples, and baths. Since then, buried streets and houses on the site of Verulamium<sup>3</sup> have likewise made their ghostly appearances as parch-marks, and recently the plans of a number of other Roman town-sites have been aerielly mapped in the same manner, for example by D. N. Riley at Alchester (near Bicester, Oxon),<sup>4</sup> and by J. K. St. Joseph at Wroxeter in Shropshire, Catterick in Yorkshire, and Mildenhall in Wiltshire.<sup>5</sup> Buried medieval foundations can,

photos and details, see *Oxoniensia*, V, 1940, pl. XX; *ibid.*, VIII-IX, pl. XIA; *Antiquity*, 1945, 148, 151. The only excavated example, near Lechlade, Oxon, was probably Romano-British or later (*Oxoniensia*, XI-XII, 44 seq.). See also *Discovery from the Air*, pl. 54.

<sup>1</sup> *Geogr. Journ.*, Jan. 1945, 47, pl. 11; *Luftbild*, 49 (contrasted markings in 3 crops).

<sup>2</sup> *Antiquity*, 1929, 182 and plate facing p. 183.

<sup>3</sup> *Journ. Roman Studies*, XXXI, 1941, pls. XIV-XV.

<sup>4</sup> *Oxoniensia*, VIII-IX, pl. XIc (in crop).

<sup>5</sup> *Journ. Roman Studies*, XLIII, 1953, pl. XII (in crop); pl. XIII. i (in grass), ii (in crop). Other parch-

naturally, react equally effectively.<sup>1</sup> In 1934 on the site of the Roman house at Ditchley, the parch-markings which revealed the plan were clearly visible by the month of May.<sup>2</sup> For a corn crop in England this was abnormally early in the year, but in Italy it would be the most likely month. It was at the end of May 1945, on the Foggia plain, that Williams-Hunt and I observed and photographed the plan of a Roman country house,<sup>3</sup> complete like that at Ditchley, with its buried walls made visible by parch-markings<sup>4</sup> in corn.

Dissimilar from the typical crop-reactions quoted, a curious and rare effect<sup>5</sup> was observed when Mill Heath, Cavenham (Suffolk), was ploughed in 1947. This heath was barren, acid soil, but was included in the current attempts to bring marginal land under cultivation. It was a dry and late year agriculturally, and much of the corn sown on Mill Heath failed to come up at all. But at one point it flourished exceedingly. This was a spot where the soil contained many tiles and a large quantity of broken mortar, indicating a buried Roman building. The outline of the building was so clear as a crop-mark that air photography was not needed. In such a dry summer the presence of building débris in the soil often has an adverse effect on a corn crop. But here the opposite was true. One probable explanation, I would suggest, is that the increased amount of lime, supplied by the mortar, corrected the natural acidity of the soil.

Occasionally it happens that markings caused not only by advanced but also by retarded growth are visible simultaneously on the same site. On Plate 4b, for example, they show the lines of buried Roman roads which focus on a point<sup>6</sup> just north of the river Nene and the town of Durobrivae on the opposite bank of the river. This excellent oblique taken by Mr. Keith Jopp in the summer of 1952 is instructive for several reasons; one is that contrasted forms of crop-marking are displayed on a single photo of a limited area. Fig. 1 shows my photo interpretation. On the *left* of the photograph the top soil is *shallow* above the gravel, and the corn as a whole was ripening and assuming a lighter, yellow tint. Here the buried ditches which demarcated a Roman road and enclosures (and also barrow circles) were revealed by corn which was deeper rooted and still of a dark green hue. But on the *right* and in the centre, the converse is visible. In this half of the field the top soil is *deeper* towards the alluvial zone along the

---

mark sites which he has published include *J.R.S.*, XL, 1950, pl. VI, 2 (Roman house at Little Milton, Oxon; crop-site) and *ibid.*, 1951, pl. VIII, 1, 2 (internal layout of Roman forts in Scotland, in crop and grass).

<sup>1</sup> Cp. the celebrated air view of the buttressed building whose plan appeared on the grass in the interior of Portchester Castle; *Antiquity*, 1938, 478, and pl. I; *Discovery from the Air*, pl. 63.

<sup>2</sup> *Antiquity*, IX, 1935, 472, pl. VI. *Discovery from the Air*, pl. 51.

<sup>3</sup> *Illustrated London News*, 1950, April 29.

<sup>4</sup> The recent accidental re-discovery of the large 'villa' that was covered by the Centocelle aerodrome, outside Rome, resulted from the appearance of parch-markings in grass during middle and late summer.

<sup>5</sup> Described by C. W. Phillips, *Antiquity*, 1947, 212.

<sup>6</sup> About  $\frac{1}{2}$  mile east of Castor railway station, and at the centre of 'Normangate Field' on the early map by E. T. Artis, *The Durobrivae of Antoninus*, 1828. Normangate Field contained the sites of a number of Romano-British pottery kilns, and Artis, pl. 40, shows an excavated example.



river, and the corn as a whole was dark green through natural, and not man-made, causes. Here, therefore, it was a reversed form of colour contrast, caused by parching in the crop, which indicated the buried metalling of two Roman roads lying close to the surface.

These Roman roads had already been studied by Mr. I. D. Margary who arranged for an aerial survey of this area in 1931.<sup>1</sup> On the ground some are still recognisable from the traces of the raised *agger* on which they lay. The line of Roman Ermine Street nearby is especially well marked in this manner. But long stretches of the smaller Roman roads (including some on Plate 4b) have been

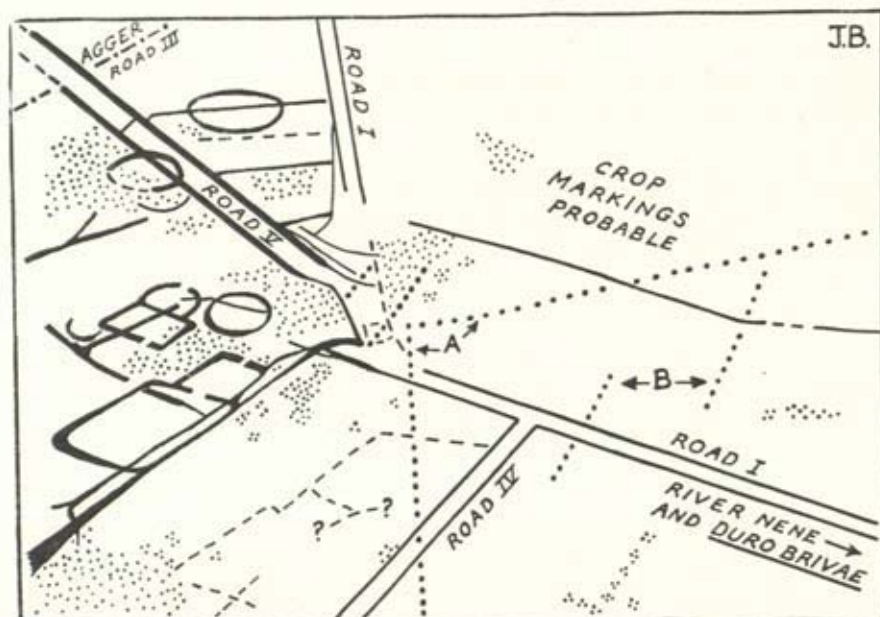


FIG. 1 Normangate Field near Castor, Northants. Plan, in interpretation of crop-marks on the oblique air photo on Plate 4b, showing buried Roman roads and enclosures, etc. The straight lines at A and B are, however, caused by modern agriculture. See p. 20.

ploughed out and ordinarily are imperceptible at ground level. Mr. Margary was, however, able to confirm several of these in 1934 by judicious probing with a steel rod to locate road-metalling.

In describing some further particulars of these roads I shall follow the numbering given them in Mr. Margary's article. The 1952 air photos confirmed that Road I began at the point where Ermine Street crossed the Nene. At the point where it changed direction (Plate 4b, centre) it is detectable on the ground as a distinct raised *agger*. This is the road marked on Artis's plan as 'Lady Conyburrow's Way'; and a portion of its continued line, beyond the area which

<sup>1</sup> Described in *Antiquaries Journal*, XV, 1935, 113-18. For other references to aerial observations round Durobrivae, the discovery of the Roman camps, etc., see *Antiquity*, 1930, 274; 1939, 178 and 455; 1945, 148 and plan.

I illustrate, was very successfully photographed from the air by Major Allen.<sup>1</sup> Let us next consider a branch, Road IV. Although so clear from the air, it was not visible during the ground-check in 1934, but probing located the metalling. Some of the 1952 photos show that its buried course does not continue to run straight, but bends north and then turns west again towards Ermine Street. Mr. Jopp's obliques also give new information about Road V. They show clearly that it did not bend before crossing Road III (as shown by earlier maps), but instead its parallel ditches maintained a straight course north-east, towards the Roman buildings on Castor Hill. Thus the evidence from the latest air photos suggests a small change in Mr. Margary's useful map in *Roman Roads in Britain*, i, 1955, 198. It is in fact quite certain that the road-system in this area was subjected to development and change in the course of time, particularly as the civil requirements of the town grew.

The last point, from this area, is a cautionary one *à propos* of the study of crop-sites.<sup>2</sup> All the 1952 photographs showed two long light-toned lines in the corn which meet at a point just east of the angular bend in Road I. Superficially, they resemble parch-markings but they are in fact thinner and fainter than the markings of the proven Roman roads, and one of them actually passes across Roads I and IV. By accident these linear markings lie close to genuine road junctions, a fact which makes them more puzzling. Fortunately, however, the photographs make it clear beyond doubt that they are modern: each line precisely bisects an opposite angle of the field, and similar straight lines can be seen in the neighbouring cornfields, where they radiate from the corners in exactly the same fashion and meet near the centre. Their origin, then, is *non*-archaeological. The study of a number of obliques proved that these crop-markings were formed by a series of consecutive turning-points made, when cornering, by an agricultural machine. Some large fields are ploughed round and round instead of up and down. Several other straight lines, caused by furrows between modern ploughing-strips, have also to be eliminated. All this proves once again that for the oblique photography of a complex site like this, it is essential to take views from all directions for comparison; and it is also a reminder that a comprehensive vertical photo would have revealed the modern markings more speedily.

In Britain the cereal crops provide the majority of markings, barley being perhaps the best, although wheat and oats rival it closely. Rye will react too. Oats has been a particularly rewarding crop in northern England<sup>3</sup> and in

<sup>1</sup> *Antiquity*, 1933, 292 and pl. III.

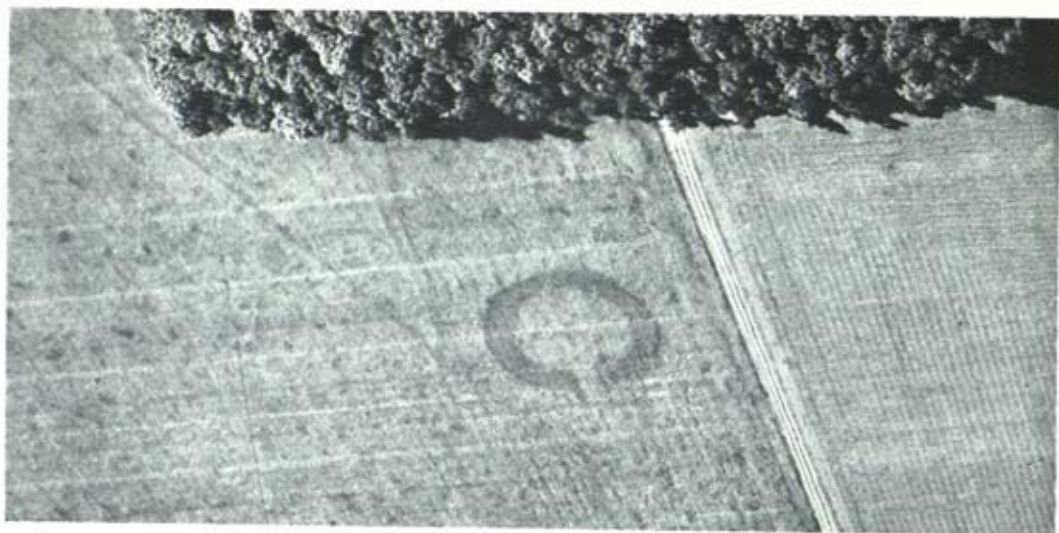
<sup>2</sup> At the centre of Plate 4, the dark mottled areas should also be noted. They are markings caused by an extra growth of weeds among the crop, which may mean that there has been some disturbance of the soil at these points. But these dark patches, large and small, are best treated with reserve until excavation has tested their significance.

<sup>3</sup> E.g. showing the buried outlines of the interior buildings of the Roman fort at Beckfoot, Cumberland (*J.R.S.*, 1951, pl. IV, 2). The crop was oats in the well-known ground photo, by Major Allen, of an Iron Age ditch in section with a corresponding crop-marking growing over it (*Oxoniensia*, VII, 1942, pl. IV).

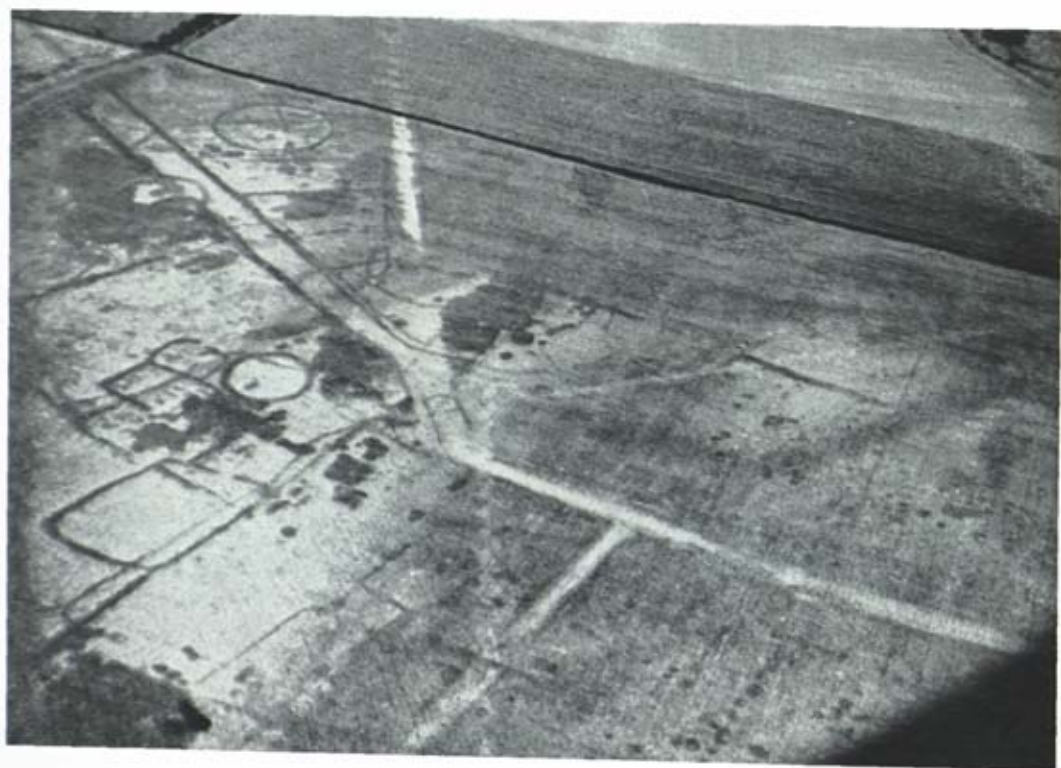




3. Near HASSINGHAM, NORFOLK. A near-vertical view of a rectangular Romano-British farm enclosure, etc. Revealed by crop-marks found from the air. See p. 17. *Ph. Bradford, July 1947.*



4a. Near STRATFORD ST. MARY, SUFFOLK. Low oblique of a circular enclosure with a broad ditch and wide entrance, resembling ritual sites of the Neolithic-Early Bronze Age. Revealed by crop-marks found from the air. See p. 17. *Ph. Bradford, July 1947.*



4b. NORMANGATE FIELD, near CASTOR, NORTHAMPTONSHIRE. Low oblique, looking east, showing buried Roman roads, etc., in the form of two contrasted types of crop-mark (of parched, and of extra, growth). See p. 20 and Fig. 1. *Ph. Keith Jopp, 1952.*





5. Vertical view demonstrating soil-marks in the actual process of formation, produced by features both artificial and natural in origin. Right: The parallel lines of two anti-tank ditches, still visible even where levelled by post-war cultivation. Left: Old channels and meanders surviving as soil-marks; those portions which appear black still contain some water. The field-pattern is of comparatively recent date. See p. 28.



6. GREECE, south of ATHENS. Vertical photo of the plain and foot-hills of Hymettos north-east of Glyphada showing the parallel lines of ancient cultivation terraces, outlined by soil-marks but mostly levelled by modern ploughing. The darker zone shows the area under grass, with ancient terracing shown by soil and shadow marks on the lower slopes. This is only a part of the very large area of old terracing found from the air. The lower part of this photo shows features described on Plate 7. See p. 30 and Fig. 2. *Crown Copyright Reserved.*



Scotland during Dr. St. Joseph's aerial reconnaissances. Lucerne<sup>1</sup> and clover usually respond very well, and occasionally produce spectacular contrasts. It is not always realised how deeply their roots can go; in the south-west United States the roots of lucerne can penetrate (after 3 years) to a depth of 15 feet into pebbly glacial subsoils! Of the root crops, sugar beet<sup>2</sup> is the most likely to show markings; turnips<sup>3</sup> and potatoes can show them but results are variable. Horse-beans have given very good results, and it was this crop which first revealed the 'Big Rings' at Dorchester, Oxon, on 16 June 1927.<sup>4</sup> In practice, the appearance of crop-markings is often accentuated by extra strong growth in the weeds as well as in the plants; this circumstance helped Haverfield, for example, when (from 1893) he and others made pioneer surveys, on foot, of crop-sites at Long Wittenham, Berks.<sup>5</sup>

But whatever the type of crop-mark, either of extra or lesser growth, the archaeologist hopes for a prolonged drought! Three or four weeks of dry weather in the summer are needed in this country for good results to be obtained, but in a spell of drought the contrasts become steadily accentuated to a dramatic degree, and many small details appear. If wet weather follows, the marks will soon grow faint and even disappear. Photography is not advisable on windy days, when the swaying stalks can blur or totally obscure the markings.

The details of crop-growth, in terms of soil-science and botany, would repay closer attention from archaeologists. To the question 'how deeply do the roots of different crops go down?' the answer is not a simple one. The vital factors are the moisture (for roots take their food from damp soil) and aeration in the soil. For example, the root-systems of cereals and sugar-beet are *able* to reach a depth of as much as 4 to 6 feet. It is thus that they have it in their power to draw visible benefit from the moister conditions of deeper soil given by buried ditches. *But* they will only develop such roots *if* conditions are dry. In a wet season, on the other hand, the same plants may not need to go down more than 1 foot; there will be little difference between their rooting abilities, and the extra depth of soil provided by buried ditches will not matter much. It follows, too, that a deep top-soil, as on many fertile plains in north and central Europe, will greatly reduce the probability of good crop-marks appearing.

It is very instructive to take the air photo of a complex crop-site, enlarge it, and compare the archaeological details that it shows with those actually

---

For a comparison of markings in oats, wheat and grass above different sectors of the same ditch, cp. Crawford, *Air Photography for Archaeologists*, 1929, pl. XVIII, Pimperne Down.

<sup>1</sup> E.g. *Oxoniensia*, I, 1936, pl. 18 and p. 18 (Cursus and barrows at North Stoke).

<sup>2</sup> E.g. enclosures at Hampton Poyle, Oxon, photographed by D. N. Riley, *Arch. Journ.*, 1944, pl. VIA.

<sup>3</sup> Differential growth in a crop of swedes helped to reveal the vanishing outlines of a Roman marching camp at Crackenthorpe in Westmorland. The roots reacted not to damp, but to the extra accumulation of well-drained humus over the levelled ramparts. I. A. Richmond, *J.R.S.*, 1943, 46.

<sup>4</sup> *Antiquity*, I, 469 and pl. I. On this occasion the site was part under beans and part under barley. The beans gave much the clearer markings.

<sup>5</sup> *Proc. Soc. Antiquaries*, 2nd ser., XVIII, 1899, 10 seq., and fig.



proved by excavation to exist. Dr. Bersu has given a good example from the interior of the Iron Age farm at Little Woodbury, near Salisbury,<sup>1</sup>—contrasting the outlines of its big ‘working-hollow’ and storage pits as shown by the crop and as finally planned. Some of the smaller pits, drainage gullies, etc., had not caused any differential growth above them. Detailed comparisons of this kind contribute helpfully to the analysis of un-excavated markings.

At present, crop-mark sites are the almost exclusive perquisite of European archaeology and ecology, although there are signs that they may develop some importance in parts of the U.S.A. (p. 80).

In Kenya the large tea and sisal plantations produce their own crop markings. Ancient hut-sites are shown by crop-failure among the tea-plants, e.g. from excess of lime in the soil. Examination of a sisal crop makes it possible to estimate the probable depth of soil at a certain point, judging by the variations in the height of the plants, which have long root systems. From many parts of the world crop sites are excluded,—in the tropics by irrigation and rice cultivation; in the archaeology of S.E. Asia they are replaced by a dense growth of scrub and trees over ancient earthworks, and we must regard these sites (together with some grass-markings) as the regional equivalent.

### GRASS AND WEED MARKINGS

Archaeologically, reactions of *extra* growth in grass, as lines of darker green, have been recorded only sporadically<sup>2</sup> during British summers. The major discovery by this means was that of the ritual ‘henge’ enclosure at Arminghall in Norfolk,<sup>3</sup> whose concentric ditches and stake-holes for timber uprights were clearly defined by luxuriant grass growth above their positions. But markings in grass resulting from *lesser* growth are a more common variety in this country, and parch-markings of this form have been relatively prolific in the north, demonstrating the layout of a number of Roman military posts and roads. The colour contrasts are sharp, give good photographs, and are unmistakable. One good example is the Roman road near Lochmaben which in the summer of 1939 emerged as ‘a dead-straight band of parched brown grass traversing pastureland that was less parched.’<sup>4</sup> A similar contrast disclosed buried buildings inside Roman forts at Kirkby Thore (Westmorland) and at Birdoswald where

<sup>1</sup> *Proc. Prehist. Soc.*, 1940, pl. III.

<sup>2</sup> Examples include the Neolithic causewayed camp (Robin Hood’s Ball) near Shrewton, Wiltshire, *Luftbild*, 31; and ring-ditches in river meadows near Oxford, *Oxoniensia*, VII, pls. 1-3; XIV, 81; XI-XII, pl. 18. Grass land on alluvial soils in N.W. Europe is usually a poor recorder of air photo sites.

<sup>3</sup> *Proc. Prehist. Soc.*, 1936, pl. I (air view by Wing Cdr. Insall, V.C., who discovered the site), and pl. III (the grass-markings defined by lines painted on the ground, to assist the excavators).

<sup>4</sup> O. G. S. Crawford, *Roman Scotland*, p. 9; and *Antiquity*, 1939, 284, pl. IVa. An interesting variant form of grass-mark was observed at Reycross on the Yorkshire-Westmorland border. The rampart of the Roman camp, engulfed in the moss, was traced by ‘a luxuriant growth of whitish bent-grass’. I. A. Richmond, *J.R.S.*, 1943, 46.



'the paving slabs of a flagged floor were clearly marked by squares of parched grass during the drought of 1949.'<sup>1</sup>

In dry zones, in various parts of the world, the roots of some grasses will fan out to depths of as much as 3 feet. In view of the archaeological importance of the markings caused by wild plants, or 'weeds' as they appear to cultivators, it is worth noting the relatively considerable depth to which their roots reach when conditions are dry,—if they can penetrate. The facts are set forth in a study<sup>2</sup> by Sir Edward Salisbury, formerly Director of the Royal Botanic Gardens, Kew. Chalk Milkwort, a tiny plant only an inch or so tall, sends roots 12 inches deep; Rock Rose (only a few inches tall) can root nearly 2 feet deep; Spurge (also common in the Mediterranean) reaches a depth of 4 feet in dunes, and such low-growing plants as Scarlet Pimpernel and Thyme go down to 1 foot and 2 feet respectively. Conditions in the well-drained habitats of chalk and dunes in Britain which he describes are reproduced to a still greater degree in southern Europe.

Such seemingly insignificant plants can exercise an important rôle in field archaeology, especially in southern Europe where they react strongly over buried sites. The failure to observe these phenomena is one reason why some regions have no markings on record.

Naturally, pasture land in Mediterranean countries is much more affected by drought than in Britain, and it is important to watch it closely between July and early October. Such pasture often contains more 'weeds' than grasses. In this period, wild flowers are often of decisive assistance, delineating the course of buried ditches in bright colours, e.g. of yellow *rugola*. Elsewhere I have given examples of their signal value on the parched plains of Apulia,<sup>3</sup> when tracing Neolithic settlements, or Roman and Medieval fields. These wild plants have long root-systems which are affected by soil-depth. Markings of extraordinary clarity were also produced by very lowly and insignificant weeds (some no larger than those that one removes from a lawn) which crowd together over an ancient ditch. It was understandable that their roots should be able to derive benefit in this way, for ordinarily there might be only a foot, or less, of soil above the rock. So abundantly clear were the markings caused by such weeds, often only a few inches high, that they revealed considerable areas of rock-cut Roman vine-trenches,—buried vineyards,—on photographs taken from an altitude of 10,000 feet (2 miles)! Every vine-trench was sharply defined on the ground by a clear linear 'weed-marking'. In Spain, South Italy, Greece and

<sup>1</sup> *J.R.S.*, 1951, 55.

<sup>2</sup> *Downs and Dunes: their plant life and environment*, 1952. See, in particular, the diagrams of root-systems.

<sup>3</sup> *Antiquity*, 1950, 85-6, and pl. VI. In Britain they play a far lesser part. Yellow charlock and red poppies will oblige occasionally (cp. *Wessex from the Air*, pl. 138; Meon Hill, Hants). One of the ritual circles (site No. 6) at Dorchester was outlined by white charlock (also called white mustard and wild radish): Atkinson and others, *Excavations at Dorchester, Oxon, 1st Report*, 1951, p. 51. Buttercups, which grew profusely on the deeper soil but not over the buried walls, sketched out in yellow the pattern of the houses and enclosures in the deserted medieval village at East Lilling (Yorks.); M. Beresford, *The Lost Villages of England*, 1954, 34.



Turkey, pasture is sere and yellow in late summer, and the setting is ideal for aerial discovery. One of the lessons that aerial study of Mediterranean countries has taught me is the importance of such 'weed marks', whether in pastures, or in stubble after crops have been cut. In Syria, of course, Père Poidebard made good use of grass and weed markings. The *vallum* of the *limes* was visible after the spring rains as a line of darker hue stretching across the steppe;<sup>1</sup> and the Roman roads were revealed by the ditches flanking them (as in Apulia), by parallel lines of grass and weeds.<sup>2</sup>

Parch-markings in weeds and grass are potent in showing buried street-plans in ancient cities of Persia, and were remarked by Sir Aurel Stein in his explorations in Central Asia (cp. p. 82 for sites in Russian Turkestan). Their importance still needs to be stressed. For example, Erich Schmidt relates<sup>3</sup> that a vertical photo of Istakhr near Persepolis, taken in the spring of 1936, was regarded as 'dirty and inadequate' by the excavators from the Oriental Institute of Chicago University until they came to realise that they were, in fact, looking at seasonal vegetation markings which showed the buried town-plan! At the other end of Asia, on the outskirts of Saigon in Indo-China, air observation<sup>4</sup> has likewise recorded grass-markings which indicate a grid of buried streets from an early city, pre-dating the fortifications of 1775, and perhaps of the Khmer period. But in Burma, Siam and Indo-China, by far the most important form of vegetation marking, from the viewpoint of archaeological discovery, is given by the growth of trees<sup>5</sup> along the remains of city ramparts and other kinds of earthwork.

All dry zones give potential conditions for grass and weed markings. Many parts of North Africa, for example, have a suitable ecology and the observation of such traces could be crucial. An instance of outstanding importance was the mapping of a lost irrigation system in Lower Egypt, dated by Miss Caton-Thompson to the Ptolemaic period.<sup>6</sup> The cycle of growth began with the rains in November and by 7 December a faintly green path had appeared on the face of the desert, due to a myriad sprouting seedlings. This was the only indication of the underlying cause,—an artificial channel now completely sand-filled and merged into the desert, but originally 6 feet deep as excavation proved. Many

<sup>1</sup> *La Trace de Rome dans le Désert de Syrie*, 1934, pl. IV.

<sup>2</sup> *Ibid.*, pls. VIII, XCIII, C, CIII.

<sup>3</sup> *Flights Over Ancient Cities of Iran*, p. 12-14 and pl. 10. 'In the fall we obtained only a fraction of the information given by the view which was taken in the spring, in spite of the fine relief of the former photograph'.

<sup>4</sup> Cp. vertical view, reproduced by P. Williams-Hunt in 'Archaeology from the Air in S.E. Asia', *Journal of the Siam Society*, June 1949, pl. 38. Describing his own aerial reconnaissances in Indo-China, P. Paris records that ancient canals of the Khmer period were revealed in vegetation 'par une couleur plus claire': *Bull. Ecole Française d'Extrême Orient*, 1931, 221; 1941, 365, 371.

<sup>5</sup> For examples see Williams-Hunt, *Antiquity*, 1950, 30-6, 'Irregular earth-works in Eastern Siam: an Air Survey'.

<sup>6</sup> G. Caton-Thompson and E. W. Gardner, *The Desert Fayum*, 1934, vol. I, p. 140 seq. For ground photos of the markings, cp. vol. II, pl. XCI, and *Man*, XXVIII, 1928, 109, and pl. G. Adjacent house mounds produced coins of 285-265 B.C. It is interesting to compare this evidence from field archaeology with that from papyri: cp. M. Rostovtzeff, *A Large Estate in Egypt in the Third Century B.C.*



other lines appeared, and within a few weeks an elaborate irrigation system took shape as an articulated pattern. The markings became very clear and were at their best in January but withered away seasonally in March before aerial mapping, which had been requested, could take place. The nature of the markings deserves to be noted, for they were produced by mesembryanthemum, a low trailing plant whose spiky glaucous leaves, and orange or pink flowers, will be familiar to most as an ornament in the garden rather than as archaeological evidence. But the essential point is that this was not an isolated curiosity but symptomatic of that large class of transient but reliable evidence from seasonal markings which must be awaiting observation in Africa, in an infinite variety of forms.<sup>1</sup>

### SOIL-MARKINGS

These occur when earthworks have been almost or completely levelled, and are visible when the soil is bare after ploughing or has only the thinnest covering of vegetation. The remains of the core of a rampart or tumulus-mound will, when exposed by weathering or when spread by cultivation, give characteristic markings which contrast with the normal colour and composition of the surface soil (cp. Etruscan tumuli, Plates 33 and 36). The colour and tone-contrast depend on the subsoil. In the case of levelled mounds of barrows or the banks of enclosures (built of rubble quarried from their ditches), one sees light markings on a darker ground. But with silted ditches (e.g. of Romano-British field-boundaries in the Fens) the tones will be reversed. In England the boldest contrasts occur on chalk and limestone; in Mediterranean lands tufa and limestone subsoils produce them just as clearly. In all terrains the contrast is at its best when rain and wind have been at work for a time and the fragments of stone or other material intrusive in the top humus have been weathered clean. It is noteworthy that fields freshly ploughed will fail to show such traces well.

The soil-mark shown on the ground photograph on Plate 32b perfectly exemplifies sites of this kind. It is one of hundreds which have revealed levelled Etruscan tumuli in central Italy,<sup>2</sup> and the cemetery of Colle Pantano in which it lies is fully described below (p. 140). The local subsoil in this instance was gypsum,—a rare circumstance which produced markings of unique clarity. Each mound, naturally, had been built with gypsum rubble dug out when the tomb and ditch were cut. The former positions of the mounds are now signalled by innumerable small fragments of white and iridescent gypsum in the top-soil. Viewed some weeks after the land has been ploughed, the circular outlines of

<sup>1</sup> In Rhodesia a distinctive flora is frequently to be seen on the sites of 'middens': Prof. van Riet Lowe particularly mentions an 'unpleasant thorny ground-creeper with masses of small yellow flowers'.

<sup>2</sup> The ploughed-down mounds of most types of European tumuli can produce a soil-mark. For examples of typical discoveries cp. *Præhist. Zeitschrift*, 23, 1932, 268 (from Glindé in Holstein); and O. G. S. Crawford, *Air Photography for Archaeologists* (Ordnance Survey Professional Papers No. 12), 1929, pl. VIII (from Grateley in Hampshire). Cited below as *Air Ph. for Arch.*



the original tumuli stand forth boldly. A special visit was made for ground photography during a fine dry spell early in October; a dry surface is needed for perfect contrasts. For as O. G. S. Crawford remarked, 'only dry chalk is white; this may be proved by taking a lump of chalk and putting it in water'. Soil-marks are much less common than crop-marks, and from their nature cannot supply the same precision of detail as the latter. But it is informative to compare the appearance of a site in these different forms.<sup>1</sup>

The actual formation of a soil-mark can be most clearly demonstrated by an example from a modern linear earthwork. The process can be seen on Plate 5 which shows a pair of anti-tank ditches dug in the last War, like the many which farmers have since been levelling.<sup>2</sup> In this case, long sectors had been almost completely filled in and ploughed over, but the line of the deep ditch and broad earthen bank survived as a white-toned soil-mark on the bare fields. The photo was taken in March. Parts of the ditches were still open and waterlogged, but in all re-filled sectors a soil-mark (from the excavated subsoil now thrown back) was forming in a characteristic manner.

Some of the best examples ever photographed are those which have been recorded in the silt Fens round the Wash. There, combined soil-markings and damp-markings<sup>3</sup> have outlined the buried ditches enclosing innumerable Romano-British fields. Aerial mapping has shown not only the details but also the extent of cultivation in this area, and Mr. C. W. Phillips has estimated that a total of no less than half a million acres is involved. When remains exist on such a scale, it is clear that the study of complete vertical photographic coverage becomes an essential.

Not only small but also large earthworks have been disclosed by combinations of soil- and damp-marks. One good example is the levelled Iron Age hill-fort at Limlow Hill near Royston in Hertfordshire, which was first made plain by Major Allen's air views. The subsoil being chalk the colour contrast was a bold one, although the outlines of the buried ditches presented a curiously blurred appearance.<sup>4</sup> This was largely due to the fact that its construction had not been completed,—an interesting reason which only excavation was able to elicit.

Years ago Crawford drew attention to a special variety of soil-sites, now

<sup>1</sup> For examples see *Antiquaries Journal*, 1940, pl. LXXXI, A, B (Iron Age hill-fort, Ram's Hill, Berks., (a) crop, 12 Aug. 1933, (b) soil, 20 Feb. 1934); *Discovery from the Air*, pls. 43-4 (enclosures near Barbury Castle, Wilts.; soil, 7 June 1936, crop, 12 June 1938); *Air Ph. for Arch.*, pls. XII-XIII (Woodhenge; soil, Dec. 1925, crop, June 1926.)

<sup>2</sup> The picture also usefully illustrates a type of soil-mark of *natural* origin:— a dead and dying meander in process of being levelled and absorbed into the field pattern. The aerial study of such phenomena and their visible remains is helpful when studying the traces of ancient river courses now under the plough (cp. the Roman 'Fiume Morto' at Ostia,—the Tiber's early bed; p. 244).

<sup>3</sup> E.g. the series of Major Allen's photos (taken in April and May) which I have described in *Discovery from the Air*, pls. 35 to 41.

<sup>4</sup> See Crawford in *Proc. Prehist. Soc.*, 1936, pl. XXV (and XXVI, similar soil-site at Hoy's Farm: photos by Major Allen, 11 Feb. 1934) and *Discovery from the Air*, pl. 23B. For the excavations, J. G. D. Clark, *P. Camb. Ant. Soc.*, 1937, 170 seq.



generally known as 'damp-markings'. These are buried ditches which in winter and spring soak up and retain, like sponges, more moisture than the surrounding soil. They then appear as dark lines when a spell of drier weather comes. But heavy rain will quickly remove the difference, and then the contrast will no longer be seen. This sequence of events was made abundantly clear by Major Allen's air photos of the 'Mile Ditches' near Royston, in Hertfordshire,—one of the most striking examples of damp-marks ever photographed, but a passing phenomenon which faded away a few weeks later.<sup>1</sup> Winter rains in most European countries would undoubtedly provide suitable local conditions for the appearance of such markings.<sup>2</sup> As the year goes on, they may change into crop-sites.

Let us next consider, at greater length, some altogether new examples of soil-mark sites, taken from Greece. This account of them owes much to helpful discussions with the late Mr. T. J. Dunbabin; a further description, with details of my field-work in 1955, was published in *Antiquaries Journal*, 1956, pp. 172-81.

Thirty years ago O. G. S. Crawford used an unusually clear series of soil-markings in order to make the first detailed map of the fine Iron Age fields on Windmill Hill in Hampshire,<sup>3</sup> and to direct attention to the urgent need of recording their existence. But ancient field systems (apart from centuriation) in Mediterranean lands have not often received such whole-hearted attention, and the archaeology of terraced fields and of the indispensable systems on hill-slopes has been rather neglected. The study of upland zones is usually neglected in favour of that of the lowlands. Cultivation terracing in the Mediterranean is generally on terrain transitional from one to the other; it is a crucial piece of the ancient landscape and its remains must one day be studied comprehensively by the comparative method and by making full use of excavation.

On Plates 6, 7 and 8 we have R.A.F. photos (1943) showing the soil-marks and other signs which have revealed considerable remains of cultivation systems along the coast of Attica, just south of Athens. These traces of former field-banks and terracing have been found throughout an area several miles in length (Fig. 2). In the Classical period there were several good-sized communities along this short sector of coast, and 5 demes can now be identified with reasonable assurance.<sup>4</sup> The remains of these field systems, partly levelled by

<sup>1</sup> For these, see *Antiquity*, VIII, 1934, 216, pls. XII and XIII (11 Jan. and 17 Mar.); cp. also the three linear ditches discovered by Allen at Deadman's Hill nearby, also from damp-marks, 26 Apr. 1936 (*Discovery from the Air*, pl. 58B). Another good example is the ditch of a large levelled earthwork at End Burgh near Old Sarum, photographed 20 Mar. 1932 (*Wiltshire Arch. Mag.*, 47, 406, pl. II, and *Luftbild*, p. 44).

<sup>2</sup> Damp-markings after autumn rains have been indicated by E. Schmidt as a means of locating Islamic graves from the air; *Flights Over Ancient Cities of Iran*, p. 17.

<sup>3</sup> *Air Survey and Archaeology*, 1924, pls. III and IIIb (diagram).

<sup>4</sup> I am very grateful to Mr. C. W. T. Eliot of the American School of Classical Studies at Athens for information on the results of his detailed studies which have clarified this difficult problem. He identifies the classical demes with the following existing places, going from north to south:—*Euonymon*, *Trachones*; *Halimous*, between *Agios Kosmas* and *Chasani*; *Aixone*, *Glyphada*; *Halai Aixonides*, *Palaiochori*; *Anagyrous*, *Vari*. He agrees that the number of demes in this area indicates that there was considerable farming there in antiquity.

modern ploughing, are very clear at the south end of Mt. Hymettos, particularly around the foot of Kiapha Drisi (Plate 6). They begin on the lower slopes, fanning out over the plain to the sea, with little relation to the modern fields. How ancient are these remains? We are trying to discover. What was their length of life? We are not certain. What chief crop did they support? We are not far beyond guess-work. In short there is a long way to go before we can approach the degree of topographical knowledge that we possess for Roman olive-

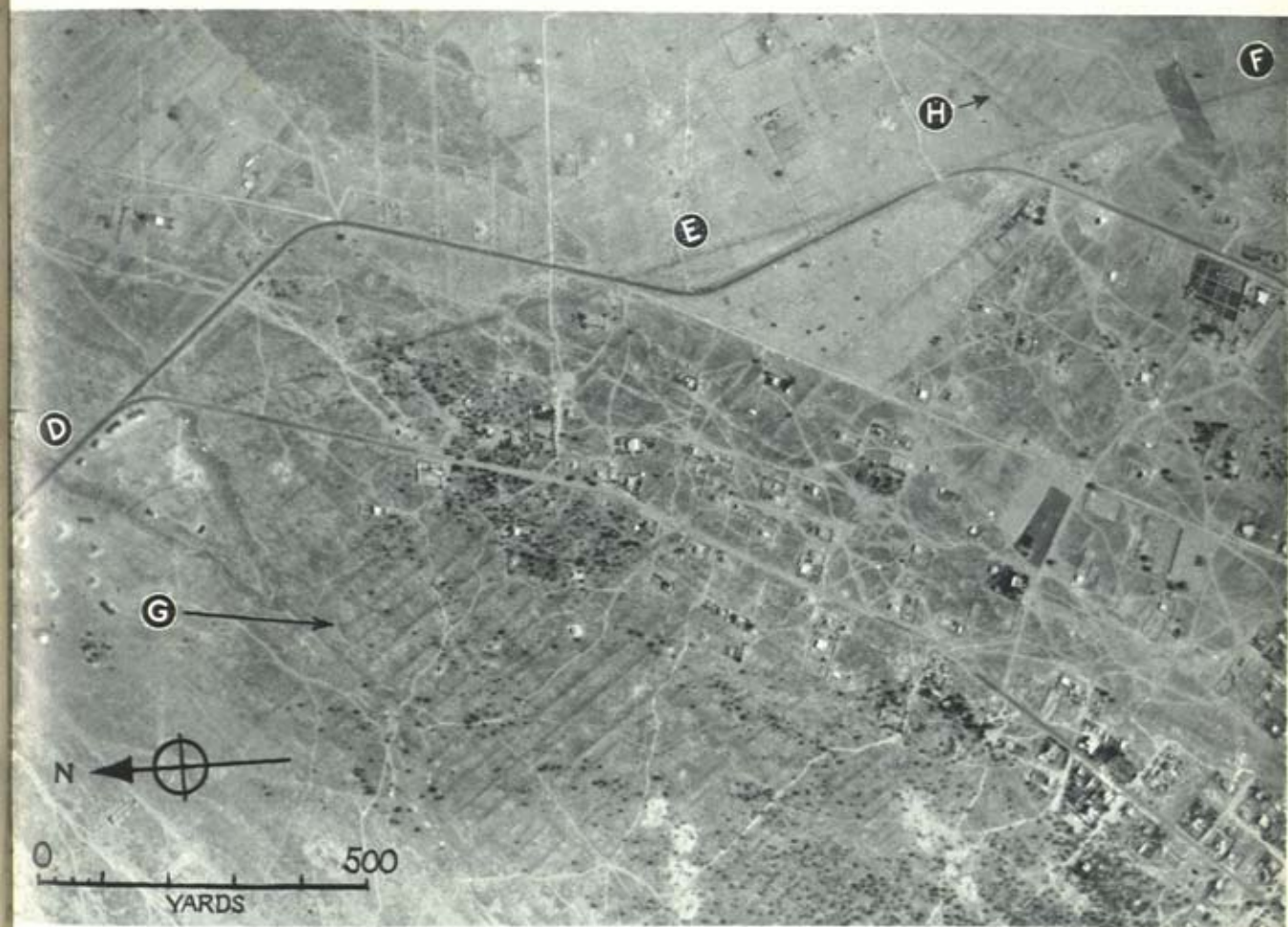


FIG. 2 Areas covered by remains of ancient fields on the lower slopes of Hymettos. A=Plate 7; B=Plate 6; C=Plate 8. These remains are also continuous between areas B and C, and between A and the sea. Spot-heights in metres. See p. 29 seq.

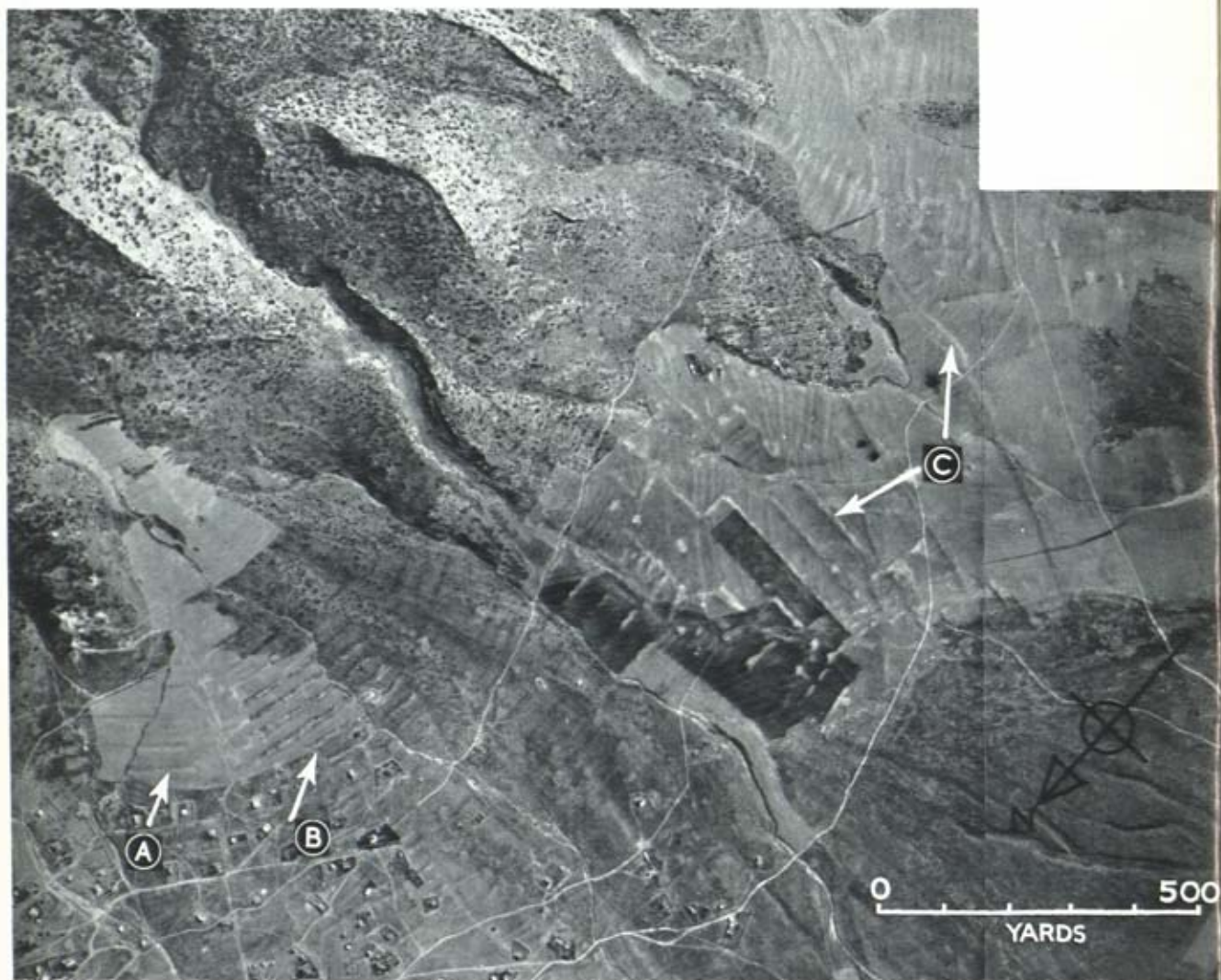
plantations on the Tunisian coast, or of Roman vineyards on the Apulian plain, where we can identify plantations complete to the last tree-pit or vine-trench (see Chapter IV). But because terrace cultivation is ubiquitous in the Mediterranean, its archaeology is often passed over.<sup>1</sup>

<sup>1</sup> Every Mediterranean country can show abandoned ancient cultivation-terraces. Some of the best are in north Syria; cp. Poidebard's air views, *Le Limes de Chalcis*, 1945, pls. XXXVI, XC and XCII,—long, thin, regular terraces resembling my Plate 6. One group (at El Bab, 71 seq.) adjoined a primitive fort with a dated re-occupation in 223-24 A.D.





7. South of ATHENS. Vertical photo (taken in 1944) of level ground in the northern suburbs of Glyphada. (D, E, F) the buried course of the ancient road to Athens, a straight dark line produced by a 'weed-mark'. Compare the ground photo on Plate 9a. (H) A dark line suggesting a buried branch-road, flanking the traces of parallel fields. (G) Soil-marks and stony ridges showing traces of old parallel field-divisions, abandoned long ago. Modern buildings, etc., have obscured all these features since this photo was taken, e.g. the gridded lines beyond (E) show new roads under construction. See p. 31 and Fig. 2. *Crown Copyright Reserved.*



8. South of ATHENS. Ancient terracing inland from Trachones, on the slopes of Hymettos. (A) Ancient terracing partly levelled by modern ploughing. (B) The same terracing still preserved as modern boundaries. (C) Soil-marks showing levelled, or partly levelled, ancient terraces. The straight lines lie along the slopes. See p. 33 and Fig. 2. *Crown Copyright Reserved.*





9. South of ATHENS: ground photos to compare with air photos of archaeological features on the coastal plain. (*Top left a*) Trachones: the ancient coastal road to Athens, as a rock-cutting in the foreground, with the continuation of its line clearly shown by a darker weed-mark. (*Bottom left b*) Glyphada: remains of one of the parallel field-divisions to the north (= Plate 7, area G). (*Above c*) The line of large stone boulders preserves traces of one of the ancient field boundaries now ploughed-over east of Glyphada. *Phs. Bradford, 1955.*



10. HYMETTOS: Ground photos to compare with air photos of archaeological features *on the lower slopes*. (a, b, c) East of Glyphada: (a) An area of ancient terracing cut by new roads, looking north to Athens. (b) The figure stands on the edge of an ancient terrace (profile marked). Late 5th to early 4th century B.C. sherds were scattered over the terrace. In the foreground, the bed of a winter torrent. (c) Centre: First stages in building a new terrace-wall, with stones from the surface, in a zone of former ancient terracing. (d) East of Trachones (Plate 8): The slope of an ancient terrace passing under a new settler's wall. *Phs. Bradford, 1955.*



These remains of defunct systems of cultivation are only 4 to 8 miles from the centre of Athens. When in Greece in 1945 I was able to fly over the zone and examine it. On the ground the remains are evident, of course, but it would be extremely laborious to attempt to map them without air photography as a guide. It is safe to say, on the evidence of personal study, that the soil of Attica offers considerable scope for aerial discovery. Systematic reconnaissance should be directed to suitable sites at the suitable season.

On Plate 7 we see a small portion of the 'buried landscape' which extends over a large area inland from the modern seaside resort of Glyphada, and, be it noted, in the immediate vicinity of those foundations and ruins<sup>1</sup> which, it seems certain, mark the site of *Aixone*. This was a large deme of Classical times, and the presence of many remains nearby testifies to its continuation as a flourishing settlement in Roman times, and up to the early Byzantine periods. It is only in very recent years that the coast at Glyphada has broken out in a rash of small scattered villas and raw new roads; prior to 1922 this zone retained a medieval pastoralism. Between the villas there are large patches of bare waste land and also areas now brought under the plough. Across both kinds of land, one can trace the soil-markings that have resulted from the abandonment and gradual levelling of ancient field-banks. These were originally composed of piles of stones,—hence the light-toned markings in the soil where they stood. They lay in lines, parallel with each other and roughly parallel with the coast. Naturally the first step was to compare the map-sheet in the *Karten von Attika* (Blatt viii), for the standard of the German field-survey was a high one and it produced better large-scale maps of this area than has any other in the sixty years since. But even this survey only recorded a tiny fraction of the layout we are discussing. The red over-print denoting antiquities marked some fragmentary vestiges of parallel lines, 1 to 1½ kms. north-west of Nikolaos.<sup>2</sup> Plate 7 illustrates one group (at G); from the air one can add considerably to those already mapped. Their straight, orderly, and methodical lines seem to suggest the Classical insistence on symmetry and discipline. On this photograph can also be seen, as a grass-mark, the buried line of the ancient main road up to Athens. It was bordered by tombs and in use from the Classical period until lately, when replaced by a modern arterial road which zig-zags at this point.<sup>3</sup>

But the German archaeologists who observed this group of ancient fields

<sup>1</sup> I.e. the 'Mauerreste und Grundmauerspuren' on the northern outskirts of the chapel of Nikolaos which lay on the edge of modern Glyphada; *Karten von Attika*, Blatt VIII (by Curtius and Kaupert, 1881-94); text, vol. III (by Milchhoefer). Cp. Pauly-Wissowa, *Real-Encycl.*, 'Aixone'.

<sup>2</sup> Other recorded examples of ancient terracing in Attica, shown in red overprint, include:—Sunion, west (Blatt XIV); Sunion, east (Bl. XV); Salamis, on north shores and mainland (Bl. XXI) and on south shores (Bl. XXII); extensively round the site of Phyle (Bl. XXIV). Some of the 'traces of wall foundations' (grundmauerspuren) are probably also levelled field-banks and walls, to judge by their length and layout (e.g. in the Olympos area, Bl. XVII). In 1955 I examined similar terracing at Nauplion.

<sup>3</sup> See Plate 9a and b. The ground photos on Pls. 9-10 show some typical details of the system. A general introduction is supplied by P. Guiraud, *La propriété foncière en Grèce jusqu'à la conquête romaine*, 1893, 181 seq. and 458 seq.



failed to show that they had a relationship with the very much larger zone of similar remains on the opposite (east) side of the road, covering the plain up to the foothills. Probably the remains east of the road were, even in 1885, not easy to trace at eye-level. The German map shows that all this zone was pasture-land then, and it only marks (in black) one or two of the most prominent terraces. But the difference between those which survive as earthworks on the west of the road and those almost levelled on the east side is not one of kind but of the condition of preservation. Their axis and the spacing of the lines are the same, and reflect the same basic methods of cultivation. It looks as though they had much in common. At the same time we should err if we treated the problem as necessarily confined to one period, either classical or post-classical *in toto*. It is essential to treat such ancient landscapes as living composite things, in which some features grow while others wither. It is worth recalling the Roman field boundaries whose outlines have been preserved by banks of piled stones in the centuriated systems at Pola (p. 175), at Zara (p. 178) and Salona (p. 183). In these systems we see that the original banks of stones of 2,000 years ago have been added to or modified by generations of cultivators up to the present day,—but the framework of the lay-out nevertheless survives recognisably.

At the back of the coastal plain, at the foot of the Hymettos range (Plate 6), recent years have brought big changes. Cultivation has returned to this area which was pasture in the 19th century, and it now resembles a great 'open field', divided into corn plots without enclosure by walls or ditches. The old terraced field banks have already been much reduced and flattened by the modern plough which disregards them and rides triumphantly over them. At eye-level they appear as low 'ribs' or ridges, with an extra content of stones in the top-soil. These war-time air photos were taken in September (from a height of several miles) at a time when the surface was bare earth.

The whole plain is not truly flat, but falls away gradually westwards to the sea. It is cut into by the beds of seasonal streams coming down from the hills, and one of the biggest problems for any early farmer would be soil-erosion. There can be no doubt that the terraced arrangement of the field-banks on the plain was used to minimise erosion; narrow units of this kind make it much easier to control. Roman farmers in Tunisia followed a variant of this policy, concentrating on small square plots (often no more than 1 *jugerum*) which they surrounded with high field-banks of stones (for details of these, see p. 201).

In 1943 cultivation ended where the slopes of Kiapha Drisi begin to rise steeply. The line is clear on Plate 6. Above, the land was only used as rough pasture for goats, and the dead terracing has survived above ground in the form of regular grassy earthworks, emphasised by their shadows and straight stony lines, and presumably accentuated by long continued ploughing. They continue for some distance up the hillside, but their furthest upper limit is very clear, reaching the 300 metre line in places. They follow the contours of the



slope in every case. The remains of these parallel banks are set from 15 to 40 yards apart, the wider intervals being usual on the plain.

The area on Plate 8 lies a little further up the coast to the north-west, and shows a zone at the south end of Mt. Hymettos. The first slopes and the ground at its foot are covered with extensive remains of levelled field-banks and terracing, with similarities to those we have just discussed. They are situated<sup>1</sup> opposite the large old farm of Trachones, which stands 2 km. westwards towards the sea; —and occupies the site of a Classical deme, *Euonymon*.

A few ancient cultivation terraces (B) are still respected by the plough, for they are too massive and their sides too stony to be levelled except by slow whittling away. They fall in bold 'steps'. But others nearby (A) have become, by now, completely covered with soil and are regularly ploughed over. Soil-marks of stony rubble reveal them. Further along (C) is a large zone of levelled field-systems on a steep slope. Here, too, soil-marks give us the plan. A point of interest is that we can see that the terracing, though following the contours, was enclosed in blocks by long, straight boundary walls (today ploughed-over); and these formed real field boundaries. Although levelled, the 'spread' banks are still up to 5 feet high.

This account is not intended to be more than preliminary, archaeologically; and it is primarily directed to demonstrate a specific kind of evidence, soil-markings. No firm chronology for these remains is possible until further field work has been done, and test-excavations made at points where these extensive remains of earlier cultivation can be related stratigraphically to a datable building (e.g. farm or tomb). Excavation has been effective in England in the investigation of the age of field-systems that survive only as earthworks.

One tends to associate extensive terracing with vines and olives, but in Attica it is today more commonly used in conjunction with cereal crops. The stones gathered off the fields are still naturally disposed of in terracing,<sup>2</sup> but the fact that the practice continues does not affect the probability of a structural origin in antiquity for some terracing that is still in use.

Having regard to the economic condition of Attica under Ottoman rule we can eliminate the possibility that the systems of terracing which I have illustrated originated in recent centuries, even if parts of them were then in use. It may well be true that use was made of them in the Middle Ages;<sup>3</sup> but we can accept the probability that in essentials their outlines were formed in Classical times, when there was a populous capital nearby to be fed. The study of Roman centuriation in the not-dissimilar terrain of Dalmatia (Chapter IV) has shown the great longevity and permanence of ancient piles of stones as field-boundaries; and

<sup>1</sup> For the siting see *Karten von Attika*, Blatt IV; but the field-banks themselves are not marked. Most of this area was pasture at that time (1882).

<sup>2</sup> The most elaborate terracing in use in the Mediterranean is to be seen where land is most precious, e.g. on islands:— notably on Pantelleria, Andros, Santorin (Thera), and on Salina in the Lipari group.

<sup>3</sup> The big monasteries (e.g. Kaisariani) at the north end of Hymettos lie a good distance away. Terracing, of course, is also observable round the sites of some deserted medieval villages in Greece.



it proved, if proof were needed, that the core of a field-wall that is still in use can be just as much of Roman date as another which is half-buried, vestigial, and acceptably 'archaeological' in appearance. The great size of many of the levelled field-banks below Hymettos, from the sheer accumulation of stones, should indicate a respectable degree of antiquity; on the other hand, terracing can grow quickly on occasion, and quite a small community can produce a large area. Fortunately some of these remains exist in the form of a dead landscape,<sup>1</sup>—one which can be excavated without the destruction of boundaries still in use. The evidence from these photographs is frankly advanced as a new problem, with the hope that it may stimulate further work 'in the field' on those three-dimensional remains which survive to reconstruct the *rural* landscape of earlier Greeks.

\* \* \* \* \*

As a postscript it should be added that the evidence collected during my field-survey in 1955 greatly reinforced the conclusion that the ancient terracing at the foot of Hymettos had its origins in Classical times.

#### SHADOW SITES

This 'portmanteau' description is applicable to a great variety of very diverse surface remains, but is retained for its comprehensiveness. It is not even always accurate, for 'high-light' (reflected light) is often a more important element than shadow itself in showing the outline. The typical form of shadow site is the earthwork with its relief emphasised by low slanting light at early morning or evening. But the sun at its noon altitude on an English winter's day can give the same effect,<sup>2</sup> and if the air is clear photographic conditions will be as good as any in summer. The desired contrasts will be most apparent when the earthwork lies at right-angles to the direction of the light, and photography must be timed in accordance with this. Any low banks or ditches which happen to be lying on the same axis as the falling light will often be hard to see, and in dealing with extensive remains (e.g. field-systems) comparative views at different hours would be the ideal recipe for a complete record. But stereoscopy (p. 59) does much to eliminate this difficulty.

However, when the light-conditions are poor and flat, even a well-preserved Roman fort can disappear and sink into the ground photographically, in a way that would satisfy any conjurer, Maskelyne himself.<sup>3</sup> For good results, full sun

<sup>1</sup> There are other suitable zones in Attica; e.g. aerial mapping would be most helpful round the site of Porthmos, to recover the full extent of the ancient field-boundary walls, to whose remains J. H. Young called attention. Cp. 'Studies in South Attica: the Salaminioi at Porthmos', *Hesperia*, X, 1941, 163-90 (esp. ground photo, fig. 10), and 'Greek Roads in South Attica', *Antiquity*, 1956, 94.

<sup>2</sup> Crawford comments that its midday altitude on the shortest day, on Salisbury Plain, is the same as its altitude at 5.44 a.m. and 6.16 p.m. on 21 June.

<sup>3</sup> The classic example was given by the square earthwork of the fort at Bainbridge, Yorkshire. See *Luftbild*, 30 (seen at 8 a.m. and 5 p.m. same day); for another instance, cp. *ibid.*, 60, Celtic fields and Roman road on Pertwood Down.



is not necessarily essential,—shafts of bright light can also serve well. Indeed, the term 'shadow-site' is often misused; for example, the topographical layout of lynchets can be perfectly demonstrated by relief when there are no shadows at all, but only reflected light thrown back by the smooth sloping surfaces facing the sun.<sup>1</sup> Grass or bare earth best produce the effects I have described, but heather blurs them (as one sees when mapping field-banks of the Danish Iron Age on the moors of Jutland).

To illustrate this category of air-photo site I have deliberately departed from the familiar repertory of sites in England, and instead have taken an example from a neighbour whose potentialities for aerial discovery are known to be great,—Northern Ireland. The ruined castle of Dunluce (Plate 11)<sup>2</sup> is perched magnificently on an isolated cliff-crag in Antrim. It was a formidable stone stronghold, one of those built in the 13th century to consolidate English rule, and changed little until 16th and 17th century additions were made; besieged in 1641, it afterwards passed out of use. Its interest for us lies in the extensive remains of buried foundations made visible, as a shadow-site, in the rough grass between the coastal road and the ruins of the great hall near the cliff edge. These remains denote the walls of dwellings and enclosures associated with the castle, and this photo gives the first clear record of their layout. Ireland should prove a rich new area of search for deserted medieval villages.

A selection of air photo sites from Northern Ireland was published by D. A. Chart (*Antiquity*, 1930, 453 seq., pls. I-VI) who included a mosaic of the huge 'Dorsey entrenchments', the earthworks of the Navan fort, and an interesting picture of two raths actually overlapping, showing clearly how one was built to supersede the other, partly over the same site. Some crop- and grass-mark sites are known from N. Ireland and Eire, but both could produce many more. Published air photos from Eire are chiefly records of known earthworks (e.g. Raftery, *Prehistoric Ireland*, fig. 19, Tara), but there is, undoubtedly, wide scope for discovery and archaeological mapping. A view of ancient fields near Caherguillamore, Limerick,<sup>3</sup> gives a foretaste of the comprehensive new data that a policy of *systematic* reconnaissance would produce.

For the most effective study of a shadow-site consisting of very slight earthworks, like those on Plate 11, it is highly desirable (and often essential) to secure pairs of vertical photos that will give the benefit of stereoscopic examination. This has been increasingly recognised since the end of the last war, in which so many archaeologists had practical military experience of the necessity for stereoscopy in detailed topographical work from air photos. It has also been

<sup>1</sup> Cp. the fine view (vertical) of the 'Celtic' field-system on Windover Down, Sussex; *Air Ph. for Arch.*, 1929, pl. V. The visual effect is increased by soil-marks from rabbit-burrowing in the loose rubble of the earthworks.

<sup>2</sup> I owe this unpublished R.A.F. vertical photo (26 Nov. 1930, 1 p.m., F.L. 6 in., 3,000 ft.) to the kindness of Mr. Martyn Jope. Prints from the National Air Survey, now extended to Northern Ireland, are proving useful; and since 1951 a number of sites listed by Mr. Jope have been photographed by Dr. St. Joseph.

<sup>3</sup> See O'Riordain, *Antiquities of the Irish Countryside*, pl. 18.



brought to notice in the recently intensified study of deserted medieval village sites.<sup>1</sup> The low grassy earthworks by which they are frequently represented form shadow-sites excellently suited for aerial mapping. Large numbers of such sites had, of course, been recorded on the standard large-scale (6 ins. to 1 mile) Ordnance Survey maps. But to survey these remains on the ground is a difficult and laborious matter; and it was not surprising to find, when the vertical stereo photos of our national air survey became available a few years ago, that an immense amount could be added from this source, and much corrected. The method of field-study was profoundly affected. Clearly, it was becoming essential to deal with the whole picture on a national basis, and the Deserted Medieval Village Research Group was formed. Several hundreds of abandoned medieval villages that were otherwise unknown have been located directly from the air photos, but, so far, attention has been mainly concentrated on the preparation of plans of the 1,300 sites known already.<sup>2</sup> This was a perfect occasion for harmonious 'combined operations' on the basis of the historical and topographical evidence, with excavation, in close support, acting as a check on both. The ancient landscapes thus revealed have many features in common, although the cause and date of abandonment naturally vary from site to site. Meanwhile the wide range of *observed facts*, now in course of collection and assimilation, will bring further precision and vitality to the social and economic record of the Age. It is to be hoped that it will not be long before the refreshing realism of 'three-dimensional' history of this kind percolates down to school text-books.

This new evidence, now accumulating with rapid tempo from England,<sup>3</sup> illustrates only our own national aspect of historical processes which are recorded both in the soil and in documents, and are best examined against the wider background of medieval economy and society in Europe as a whole. All countries have such abandoned sites; in Denmark and in west-central Europe excavation and historical geography have attacked them very effectively. And in Apulia, for instance, my own studies have shown further examples on Italian soil;<sup>4</sup> their plans and the remains of the abandoned trackways and defunct field-systems that were associated with them, have now been mapped from the air and ground-checked, and are awaiting detailed publication.

<sup>1</sup> The origins of this study go back to the 19th century. The first aerial plan of such a site was published by O. G. S. Crawford, *Antiquaries Journal*, 1925, 432, and pl. L; an evocative vertical view of Gainsthorpe in Lincolnshire. Previously there had even been a doubt as to whether it might be a Roman camp, but a single photo decided the nature of the site, with its buried streets and houses.

<sup>2</sup> The Group intends to compile a complete set of the stereoscopic photos (1 : 10,000 scale) from the National Air Survey that cover these sites. In addition J. K. St. Joseph has taken hundreds of oblique photos of deserted and shrunken village sites.

<sup>3</sup> Summarised by M. W. Beresford, *The Lost Villages of England*, 1952 (with 11 air photos, all of shadow-sites in grass) and in *Geogr. Journ.*, 1951, 129; also by county historians (especially W. G. Hoskins) and by a series of articles in the *Archaeological News Letter*.

<sup>4</sup> E.g. *Antiquity*, 1949, 70 seq. and pls. Vb and VI (sites at Torriione del Casone and San Lorenzo near Foggia); *ibid.*, 1950, 91 seq., ground-air study of the abandoned medieval port and town of Salpi on the Gulf of Manfredonia.



The determined application of systematic field archaeology to Medieval earthwork, which promises revolutionary results, recalls the time (a mere thirty years or so ago) when the 'shadow-sites' of Celtic fields were first rescued from the penumbral shades of neglect by O. G. S. Crawford. The Iron Age was then a 'dark' age still, and the inhabitants were as shadowy as their fields! But the latest survey, by P. P. Rhodes,<sup>1</sup> with its clear-cut maps, shows how far ground-air reconnaissances have since progressed towards recreating an ancient landscape that is not simply a collection of parts but one that we can envisage as coherent and workable. These upland field-systems so familiar in the south have northern counterparts which wait to be recorded fully by aerial mapping. Twenty years ago an Ordnance Survey—R.A.F. vertical photo<sup>2</sup> (an outstandingly fine view) of the great block of fields visible at Grassington, in Yorkshire, demonstrated what could be seen and done. Likewise the remains of strip-lynchet cultivation (normally still dated by guesswork!) are as much in need of attention in the north as in the south; air views by Crawford and Alington<sup>3</sup> of long strip-lynchets in Lanarkshire and on Arthur's Seat, Edinburgh, make one anxious to compare more from other areas. The archaeology of strip-lynchets is not a local but a national problem.<sup>4</sup>

In reconnaissance flights, oblique photographs, specially posed from the ideal angle of lighting, are unsurpassed for putting the best face on individual earthworks, but for the systematic mapping of shadow-sites the demand should always be for a continuous series of vertical photos, giving complete coverage and stereoscopy. An ideal demonstration of the use of photos of the latter type was given by P. P. Rhodes, who has mapped a total of 7,350 acres of 'Celtic' fields from one area alone, linking-up blocks ranging from 5 to 2,000 acres. In front of me, as I write, is a table covered with vertical prints, selected from those of the

<sup>1</sup> *Oxoniensia*, XV, 1950, 1-28, 'The Celtic Field-Systems on the Berkshire Downs'; the type was in use from the Late Bronze Age and throughout the Roman period. It is instructive to compare those in the form of (i) shadow sites and (ii) buried sites,—likewise in the case of the Romano-British fields in the Fenland where some areas have remained untouched since abandonment. Both forms are seen together on a photo of a system near Cottenham, Cambs. (J. G. D. Clark, *Ant. Journ.*, 1949, 145, pl. XIV and plan); cp. G. W. G. Allen's view of a Romano-British field-system as a shadow site, in permanent pasture, at Gedney Hill, Lincs. (*Antiquity*, 1945, 145 and pl. II).

<sup>2</sup> *Luftbild*, 52. Other air views in *Yorks. Arch. Journ.*, 1937, 166-74 and *J.R.S.*, 1950, pl. VI, 1. Excavation showed that the fields were late Iron Age and Romano-British. An excellent R.A.F. photo of the fort at Housesteads on the Roman Wall (*Antiquity*, 1931, 351, pl. II) showed how well vertical views record field systems from shadow relief. Other remains of ancient agriculture in the north have been photographed by J. K. St. Joseph.

<sup>3</sup> *Antiquity*, 1939, 280, pl. VII; see too, *ibid.*, 1928, 166; and 1929, 165 (strip-lynchets in Wharfedale).

<sup>4</sup> It is by no means certain that all groups of strip-lynchets are automatically post-Roman in origin, although the majority doubtless are. Only excavation can decide this major problem; at Bishopstone, Wilts., it gave a hint of possible Iron Age use (*W.A.M.*, LVI, 12-16); cp. Twyford Down, *Proc. Hants. F.C.*, XIII, 190, and Prof. A. A. Miller in *The Advancement of Science*, XI, 277-9 on 'The mapping of strip-lynchets'. Col. C. D. Drewe stressed a relation between lynchets and strip-fields on Portland (*Antiquity*, 1948, 79-81); C. W. Phillips, and others, have instanced air photos showing long fields of Roman date in the Fens and elsewhere (cp. *Aspects of Archaeology in Britain and Beyond*, ed. W. F. Grimes, p. 267). *R.C.A.M. (Scotland)*, *Roxburgh*, vol. i, 1956, pl. 29 shows an air photo of fine strip-lynchets on Braemoor Knowe.



National Survey to show 'Celtic Fields' in Southern England. The photos were taken in October, November and April, when the light is not strong but the upland grass is short and low earthworks stand out well. The lynchets run in all directions, and those on the same axis as the falling light are sometimes hard to see if a single print of any kind is used. But, examine these vertical photos stereoscopically in pairs, and the dubious lynchets will 'stand up' in relief even though they were negligible as shadow-sites at the time of photography.

Ancient roads and trackways form one of the most important classes of shadow site (p. 12, note). I cannot do better than refer to the vertical photo of Pertwood Down which visually established the relation of the earlier double-lynchet way and the Roman road which re-used part of it. An instructive example of a different kind is that given by a vertical view of Cherhill Down, disentangling tracks and linear ditches of all ages up to the present.<sup>1</sup>

Shadow-relief reaches the height of its effectiveness when there are superimposed earthworks which must be separated. Of the many examples that could be mentioned, the air view of the remains of the strip-lynchets overlying earlier 'Celtic' field-boundaries on Thornham Down, Wiltshire<sup>2</sup>, is a particularly pleasing instance of a complete and tidy separation made apparent by this means. In this case, of course, the order of *sequence* was obvious, but with some overlapping earthworks it is less so. One of the first and best aerial demonstrations of sequence was that which conclusively showed the relationship of the Iron Age hill fort at Quarley Hill to an earlier ditched enclosure, subsequently proved by excavation to belong to the Late Bronze Age (perhaps a ranch boundary).<sup>3</sup> Occasionally an aerial plan-view of shadow-relief will also illustrate the actual manner of earthwork construction; there is the case of the unfinished Iron Age hill-fort built by gang-work at Ladle Hill, Hampshire.<sup>4</sup> The interrupted, 'causewayed', construction of ditches of the type that enclose British Neolithic sites can sometimes be identified by a characteristic irregularity in their outline;<sup>5</sup> typical too are the grassy hollows of small quarry-pits, dug for ballast, bordering some Roman roads in Scotland and others in Wales and England.<sup>6</sup>

Large and complex sites on unploughed grass-land, notably Roman field-fortifications in the north, can be pre-planned from shadow relief before excavation begins. And even in the south, where field-work has been so intensive,

<sup>1</sup> *Wessex from the Air*, pl. XXVI, Pertwood; XLIV, Cherhill.

<sup>2</sup> *Antiquity*, IX, 1935, 89 seq. and pl. I. For other illustrations of this type of site and its elucidation, cp. *Proc. Prehist. Soc.*, IV, pl. V, and *Wessex from the Air*, passim.

<sup>3</sup> Crawford, *Air Survey and Archaeology*, 1st ed., 1924, pl. 10; C. F. C. Hawkes, *Proc. Hants. F.C.*, 14, 1938-40, 136 seq.

<sup>4</sup> S. Piggott, *Antiquity*, 1931, 474 seq., pls. I-V. Even the builders' shallow 'marking-out' ditch (the preliminary stage of construction) could be seen.

<sup>5</sup> Cp. E. C. Curwen, *Antiquity*, 1930, 32 and plate IV. Even when they lie buried, the 'quarry' construction indicative of Neolithic ditches can be recognised from crop-marks, e.g. on several of Allen's photos of 'henge' sites near Dorchester, Oxon.

<sup>6</sup> Crawford, *Antiquity*, 1939, 283 and pl. IIIA; St. Joseph, *J.R.S.*, 1953, 93.



Allen was able to discover a whole new sub-species of earthwork in this way,—an unusual group of no less than 50 large circles round Highworth near Swindon.<sup>1</sup> In most of the Thames Valley and in the Fenland, Bronze Age tumuli are negligible as shadow sites, having been erased by cultivation; but, *there*, air reconnaissance by Allen and Riley has restored their distribution to us, in the form of crop-sites, balancing the numbers of tumuli preserved above-ground on the chalk Downs.

Up to this point I have taken my examples from British shadow-sites, because of their diversity and the close attention they have received. There have, in fact, been very few comparable attempts at such study from other European countries, as a search through archaeological and geographical journals confirms. In Germany, for example, surprisingly little on this theme has been published. This is all the more curious when we remember the activity by Zeiss and other firms in the field of orthodox aerial survey.<sup>2</sup> The German archaeological air photos in *Luftbild und Vorgeschichte*, which gave a selection of the best up to 1938, illustrated few sites which were actual discoveries. The emphasis lay chiefly on the display of general views of individual earthworks already well-known, and the 'discovery-potential' of air archaeology was not sufficiently exploited. The exposition of known sites in their topographical setting has usually sufficed as the simple aim of most air photos published in European countries. In Spain a number of general views of famous sites have been taken for archaeologists.<sup>3</sup> Interest in crop-marks and other forms of buried sites, which must exist in large numbers, was stimulated by an exhibition of British archaeological air photos recently shown in many Spanish cities through the agency of the British Council. The techniques of air-search for revealing *new* sites have been demonstrated to other countries: one exhibition arranged by the Ashmolean Museum in Oxford, which included photos illustrated in this book, has recently been on tour in Italy.

The use of air reconnaissance by French archaeologists has been chiefly directed outside metropolitan France, whose potentialities have been overshadowed by the pre-war and post-war discoveries in Syria, Tunisia, Algeria and Indo-China.<sup>4</sup> In such regions, the remains above ground are so super-

<sup>1</sup> They lie on clay land that is unploughed and under grass; the bank is placed outside the ditch. Their date is still uncertain; cp. *Oxoniensis*, VIII-IX, 70 and fig. 26; *Luftbild*, 34. Shadow-relief is useful in defining the forms of all tumuli, as for instance when two or more are enclosed by a single ditch (Grinsell, *The Ancient Burial Mounds of England*, pl. IV, 2nd ed. 1953).

<sup>2</sup> Vertical photography for map-revision was much used in France, Italy, Germany, etc., before 1939 (though mainly at small scales). E. de Martonne's short introductory study, *Géographie Aérienne*, 1948, includes a map showing its progress in France (fig. 19).

<sup>3</sup> Cp. M. Almagro, *Ampurias*, V, 1943, 247-9 and 3 pls.; J. M. Santa-Olalla, *Esquema Paleontológico de la Península Hispanica*, 2nd ed., 1946, also contains several views of hill-forts as shadow sites (pls. LVIII and LIX reveal interesting details of internal planning). Pidal's *Historia de España* has some panoramic views of hill-forts and a few classical sites.

<sup>4</sup> Mention must be made of the notable results obtained in the last few years by Dr. Groslier of the Ecole Française d'Extrême-Orient at Saigon. Dr. Groslier has kindly sent particulars of the highly important remains of ancient cities, irrigation canals, etc., of the Khmer (7th to 15th centuries A.D.), which he has been



abundant that the case for straightforward aerial mapping strikes the mind and eye at the same instant. Even on camel-back, as Poidebard has remarked of Musil's surveys in the desert, one obtains an appreciable advantage. It might seem almost pedantic to apply to great areas of ruins in Asia the terminology that we use for small sites in Europe, and to place a Bronze Age tumulus in England and a Sassanian city in Persia together under the heading of 'shadow-sites.' But in actual practice, one simply re-encounters the basic principles of vegetation, soil, and shadow indications in a different regional form. Many big sites in the Afrasian Dry Zone, from North Africa to India, often exhibit a combination of all these traits simultaneously,<sup>1</sup> and there are numerous small features (important collectively) which can only be recorded by giving careful attention to these principles. One may cite, as a typical instance, the complex networks of low banks that enclosed irrigated plots in Roman Algeria, and which have in some cases been reduced by weathering to a height of a few inches only.<sup>2</sup> Such pygmy earthworks can appear so obvious from the air that one may be misled into thinking that they will be equally obvious when one later explores them on foot, in the course of the necessary ground-check in search of datable finds. Often the result is quite the opposite! Baradez recalls that when he had finished his study of the photos of the Roman defence lines in Algeria, he could not believe that what he had discovered had not been noticed before. However, when he made his ground-check on foot, it was often only with the photographs in hand, and by measuring distances and identifying surface details one by one, that he was able to find the remains of the chief element, the continuous frontier earthwork of the *fossatum*. On one occasion, in the blinding light of the midday sun, which is a great leveller of earthwork-relief, he twice walked across the *fossatum* without recognising it! In some sectors the broad low bank of the *fossatum* was rendered visible less by its relief than by the extra quantity of small pieces of rock on the surface, weathered-out from the core.<sup>3</sup> Soil-marks, in fact, often make a decisive contribution to the visibility of shadow sites (e.g. in the case of partly buried walls, showing from the air as whitish lines in steppe and desert). Precise observation of the physical *minutiae* which enable

---

able to record from the air in Cochin-China, Cambodia and Tonkin (in spite of the limiting factors of tropical forest and regions of intensive cultivation). City-sites that belong to the Fou-Nan period, i.e. the first centuries A.D., have also been mapped in the same way.

<sup>1</sup> E.g. Poidebard, *Le Limes de Chalcis*, pl. LXXIII showing surface markings, caused by buried walls of sun-dried brick, only clear from the air.

<sup>2</sup> Baradez, *Vue aérienne de l'organisation romaine dans le Sud-Algérien*, 1949, pls. 187-90, 167-8, etc. In dry-zone conditions, the whiteness and reflected light of stony earthworks play a larger part, photographically, than shadow. I take this opportunity of mentioning an interesting and little-known discovery in which shadow-relief was an important factor: 15 km. west of Tebessa on the hilly border of Algeria and Tunisia, air photos have revealed a zone of more than 750 hectares covered by long-abandoned ancient fields, small, terraced and enclosed by walls. A detailed report with maps by R. Hirigoyen (1947), shown to me by courtesy of the Institut Géographique National, claims evidence from finds in favour of a prehistoric date.

<sup>3</sup> Baradez, pl. 41B.



sites to be seen and found is always important. Discovery frequently depends on attention to such details.

### SPECIAL TYPES OF SITE

Concentration on the basic varieties of air photo sites which I have just described would alone be enough to keep field archaeologists busy in all countries for a generation or more. But special circumstances produce other kinds which call for attention. Of these the most notable are the ancient coastal sites, part in and part out of the water: the off-shore remains at Carthage, for example, I shall discuss in due course (p. 231 and Plate 56). Poidebard's three seasons at Tyre<sup>1</sup> furnish the model for the systematic investigation (literally *à fond*) of such sites, combining ground and air archaeology with reconnaissance by divers. On the west coast of Italy a vertical view of the Roman harbour at Anzio, now under water, well recorded its outline.<sup>2</sup> But photography is only successful under favourable circumstances of clear, shallow and calm water. Seasonally, such conditions obtain round a number of ancient ports in the Mediterranean (cp. Delos, p. 274 and Plate 72). The suitability of conditions in Spain, Crete and Cyprus may be instanced among others.

All round the Mediterranean are numerous promising sites for the use of air reconnaissance, where the remains of Greek or Roman moles and quays can be seen at eye-level at low-water. Recently, attention has been specially directed to those in Provence,—on beaches at Fos, St. Tropez, Hyères (*Olbia*), Antibes,—and in Corsica,<sup>3</sup> while the possibilities in Greece have again been canvassed.<sup>4</sup> Diving is particularly adapted to reconnaissance of small targets like a sunken ship,—air photography to the mapping of extensive structural remains (unless buried in silt). At Apollonia recent underwater explorations have shown the layout of the ancient port. In central Tunisia, too, air photography has revealed an important mole in the sea at the site of the ancient port which is believed to be Acholla.<sup>5</sup>

Apart from Poidebard's work, the use of air archaeology in the study of submerged areas and underwater detail has usually been a 'hit or miss' affair hitherto,—for predictable results depend on the skilled use of photographic techniques designed for the purpose. Experimental proofs of what constitute

<sup>1</sup> *Un grand port disparu, Tyr*; 2 vols., 1939. Pls. VI-XII give good air photos of its ancient ports and semi-submerged quays, pls. XXVI-XXVII of Saida (Sidon) and old ports on this coast. For other air views of remains off-shore, see *Antiquity*, 1927, pl. III, p. 14 (Scilly Is.); *ibid.*, June 1954, pl. IV (unknown site).

<sup>2</sup> G. Lugli, *Saggi di esplorazione archeologica a mezzo della fotografia aerea*, tav. I-III (Istituto di Studi Romani) 1939. This booklet marked the first organised experiments in air archaeology in Italy.

<sup>3</sup> F. Benoit, 'L'archéologie sous-marine en Provence', and N. Lamboglia, 'La Nave Romane di Albenga', in *Rivista di Studi Liguri*, July-December, 1952.

<sup>4</sup> R. Demangel, 'Une ville grecque engloutie: Helike', in *Bull. van de Vereeniging*, Leiden, 1949-51, 29; *Bull. de Correspondance Hellénique*, 1950, 271.

<sup>5</sup> C. Saumagne, *C. R. de l'Acad. des Ins. et B.-Lettres*, 1952, 296.



the best techniques have long been needed. These we now have at last, owing their origin to tests for military purposes made by the Army Photographic Research Unit in 1944-5. These trials, in which 10,000 air photos were taken, have been analysed in a valuable monograph<sup>1</sup> by Mr. J. Grange Moore, on which the following account is based. Experiments were made in widely separated regions: Cornwall, the Scilly Islands, in the Mediterranean, Ceylon, etc. The purpose was to aid the photographic discovery and interpretation of beach gradients and of underwater obstacles off-shore.

During the war I had experience in tasks of this kind, and was able to judge the potentialities for application to archaeology. Thus, if you take photographs as for land surfaces, the sea will usually appear inky black and impenetrable, so that reefs, submarine contours or remnants of man-made structures underwater will be scarcely visible. But suit the method to the subject and the seascape under shallow water will, in favourable conditions, be made almost as apparent as the landscape. The results of the tests described by Mr. Grange Moore are of utmost importance for the study of a wide range of problems in historic and prehistoric coastal sites.

Many technical details are given, and I shall summarise those of particular relevance to archaeology. The air photos were a series of verticals, automatically exposed and giving the normal overlap for stereoscopy. A scale of 1 : 7,000 was found to be ideal for very detailed interpretation (the stereoscope, of course, enlarges this two or three times). Archaeologists would prefer a scale as big as 1 : 3,500, but very large scales may show too much wave-detail. Two or four cameras were mounted with different filters and film for comparison, photographing the same area simultaneously. Those of 8 inch focal length were used from a height of 5,000 feet, producing 5 × 5 inch prints each covering an area 1,000 yards square at a scale of 1 : 7,500. Very good results were also obtained with 20 inch cameras from 12,000 feet. These gave prints of 8½ × 7 inches, each covering an area of c. 1,700 × 1,400 yards at 1 : 7,200. The correct planning for a photographic sortie of this kind was worked out by experiment.<sup>2</sup> The sky should be free from cloud or fully covered by high cloud, and the sun should be between 30° and 50° above the horizon. With a low sun the illumination of the sea bed is reduced, while above 50° the sun produces specular reflection from small waves. Around harbours and beaches, photography on an incoming tide is preferable, as local pollution of the water may be very marked after high tide.

The crucial value of the experiments, however, lay in their dramatically

<sup>1</sup> 'The Determination of the Depths and Extinction Coefficients of Shallow Water by Air Photography using Colour Filters', *Phil. Trans. Royal Society*, series A, No. 816, vol. 240, pp. 163-217, published 21 January 1947.

<sup>2</sup> Days of low or no wind at the sea surface should be chosen. Reflection must be minimised (e.g. a beach facing east should be photographed in the morning rather than the afternoon). Best results came from cameras of over 8 inch focal length, with speeds down to 1/100 sec., apertures of about f. 4 (f. 6.3 is too small), and an acceptance angle of under 48°. Observation at sea level replaces fieldwork on foot (i.e. with Secchi disc readings, etc., for checking depths). 'Light-toned', not 'contrast' prints, are essential.



effective demonstration of the contrasted abilities of different colour filters. The two best were Wratten 56 (green) and Wratten 27 (red). 'Coastal sea water will normally be most transparent to light of wave-length about 4,500-5,800 Å', and for this a *green* filter used with panchromatic film was proved to be most suitable. This is the combination which revealed underwater detail to the greatest depth, even down to 50 feet. A red filter is chiefly suitable for very shallow water, and detail is not likely to be seen below 20 feet. Explorations by sea divers, in the manner of Commander Cousteau, operate considerably deeper of course, but such reconnaissances are at selected points and are not intended to map extensive areas.

Visible proof of the techniques best suited to archaeological needs is given by the comparative photos that are illustrated. Some reveal the underwater features as clearly as the print on a page. Those of Cavalaire beach in southern France (Moore, *op. cit.*, pls. 3-4) show how every particular of the underwater contours off-shore, and a line of anti-landing obstacles submerged at a depth of about 8 feet, were revealed. Here, a green filter was more useful than a red, and the same was true at St. Maxime on this coast (pls. 1-2), and at the entrance to Penzance harbour (pls. 14-15). All these photos were taken in June and July 1945. Photography with infra-red sensitive film did not, normally, produce results of equal value, in terms of probable archaeological needs. The amount of detail visible under shallow water off St. Mary's in the Scilly Isles (pl. 7, red filter) suggests a use for this method in the study of certain ancient land-surfaces now submerged through the sinking of the coast.

Shallow flooding on land accentuates minor differences of relief, and those of archaeological significance may be made more apparent. One could scarcely hope for a better example than that photographed by Major Allen (5 June 1937) at Welney Washes, Norfolk.<sup>1</sup> Localised flooding had made plain the siting of a Romano-British settlement, strung out in ribbon-development on the banks of a stream long dry; this stream ran on a *levée* whose remains stand a few feet above the surrounding fenland. Water had seeped from the flooded areas into the grassy hollows of the Roman stream-bed and farm-ditches, thus displaying their outlines. In Wattenmeer, Holstein,<sup>2</sup> the slightly raised sites which had been occupied by medieval villages, since abandoned, were isolated and made clear in a similar fashion. Later, I shall show (p. 248 seq. and Plate 60) how well the effects of modern flooding re-created the topographical setting of the Roman harbours, now inland, at Ostia. There are also areas habitually marshy, in which detailed air mapping of waterlogged soil and surface relief could assist the study of ancient topography; one might instance sites in river deltas (e.g. that of the Po), and the Roman ports of Pisa and Ravenna, since abandoned by the sea.<sup>3</sup>

<sup>1</sup> *Luftbild*, 58. Excavation showed that the site was occupied during the 1st to 4th centuries A.D. *Antiquity*, 1936, 95 and *Discovery from the Air*, pl. 35.

<sup>2</sup> *Luftbild*, 84.

<sup>3</sup> Swampy ground or peat bogs sometimes contain lurking sites that can be found from the air: e.g. *Antiquity*, 1930, 457, pl. VII, markings of concentric earthworks, Northern Ireland.



Examples of discoveries will be given from Salamis in Cyprus, and from Rhodes (p. ix; p. 280, n. 2; and Pl. 74d).

Among other exceptional conditions,<sup>1</sup> I should also mention the effects of white frost and of snow, occasionally important. Small differences of surface-relief are revealed with remarkable clarity and precision by light falls of snow, and some kinds of earthwork are extraordinarily well shown, especially from the air. 'Celtic' fields and trackways are one such class; Piggott<sup>2</sup> has given an example from the south, and Raistrick<sup>3</sup> another from Grassington in the north. In the south-west, too, a vertical survey of Dartmoor or Bodmin Moor in sunny weather after a light fall of snow would give an excellent photo mosaic, with ancient settlements, hut-circles and field-systems mapped in black and white. G. A. Holleyman confirmed this when flying over the area in January 1945. Slight snow had fallen the day before, and as a result all these features from the ancient landscape were thrown into dark relief against a grey and white background. As an example of technical interest, I give on Plate 12 an instance from southern Germany. On the right is a village; traces of old trackways (A, B) which radiated from it, before the present mathematically straight field-divisions were made, become visible through the snow that has drifted into the slight hollows which still remain. The modern strips pass over them, and the trackways have long been abandoned and buried. In the centre, the existing fields now have a new orientation but the original positions of the ditches between the strips can still be seen, running diagonally (C). The original scale of this vertical view was 1 : 10,000,—a useful photographic scale for the study of large systems of cultivation.

### TERRAIN STUDY

This is intrinsic to all field archaeology. As regards the aerial arm, the aim is the visual extension of the tale told by maps,—with the emphasis on the stage rather than the players. We shall see one typical aspect of its use when we examine the changes in the coastline and environs of Roman Ostia (p. 246) and the geological setting. The basic topography shown by the map is augmented by the realism, the extra details, and the three-dimensional view, inherent in large-scale vertical photos. The choice of city site, route or even cave-shelter required generalship, and the ancient geographical factors often need to be 'fouillés des yeux.'

Terrain study also turns an eye to the way in which the *living* landscape is constructed, before hurrying into its past. Field archaeologists have long been in agreement on the value of observing *how* boundaries are laid out in practice,

<sup>1</sup> E.g. the 'robber trenches' which revealed the walls of the Greek city of *Euesperides* near Benghazi, *Antiquity*, 1952, 208-12 and plate.

<sup>2</sup> *Antiquity*, 1930, 187 and pl. I (air view).

<sup>3</sup> *Yorkshire Arch. Journ.*, 1937, 166-74; the snow on the 'Celtic' field-banks melts quickly and they appear as dark lines on the general white background.



field-shape suited to land-form, trackways made or broken, or old systems replaced by new. The air view, especially the vertical photo plan, simply gives further expression to this point. I have in mind an instance from Central Europe where the air view clarifies the map: the scene is a plain bordered by low hills. The long strip-fields on the level ground become shorter and shorter as the slope rises gently, until they become square and finally terraced. Every gradation is present, with completely diverse types of field-shape at the opposite ends. Considered separately, the extremes might be taken to typify two different traditions of agricultural practice, but in fact one can see that they grew organically out of the landscape.

Let us consider an unusually clear example of the replacement of one landscape by another (Plate 13). When working with air photos in Greece during the last war I noted remains of old field-patterns west of Salonika which are of special interest for topographical archaeology. They illustrate a vital stage in the almost total re-modelling of a traditional landscape,—a phenomenon which we often consider historically but can rarely demonstrate comprehensively or conveniently at first-hand. This region, the Kambanía, was prior to 1920 a backward zone, with numerous poor villages surrounded by a network of innumerable small enclosed fields of sub-rectangular shape, dissected by wandering lanes and tracks of gradual and unhurried growth. A few scraps of this layout still survive, and Plate 13 shows one group of derelict field-banks to the south of the village now called Adendron<sup>1</sup> in Western Kambanía. The fragments of this now-extinct landscape, which are scattered over a large region, have a curious resemblance in general appearance to our 'Celtic' fields in England. Three stages can be seen on this photograph, taken at the end of May: (i) the abandoned fields, (ii) the area nearer the village which has only just been partitioned and where traces of the old system still survive as crop-site markings, and (iii) all round, the new landscape which has removed almost all vestiges of the old.

The metamorphosis followed a pattern often repeated in history. Before the 1912-13 Balkan Wars, 20 to 50 per cent. of the villagers in this part of the Kambanía plain were Moslem, and in consequence of political events a large exchange of population took place. Nearly every settlement has a new name and has been enlarged on a grid plan. New villages were built and Lake Yiannitsa was drained. The effect of the changes has been very great throughout the region, most of all on the fields and method of land division. The whole regional landscape was transformed by a methodical repartition based on parallel roads having some resemblance to the regularity of Roman centuriation (Chapter IV). It is worthy of note that in southern Europe there is generally not much difficulty in distinguishing a survival of genuine centuriation and a modern regularisation.

<sup>1</sup> Between the Axios (Vardar) and Aliakmon rivers, 4 miles west of the main railway crossing over the Axios. The derelict fields survive in areas left as rough pasture, often near villages; their markings were noted by O. G. S. Crawford when travelling by air in 1938 (*Proc. Prehist. Soc.*, 1938, 237).



One criterion is that the 'improvers' of recent and modern times have not the same regard for a uniform orientation throughout a big area,—their blocks of gridded land are much smaller, fitted into convenient spaces, and given any orientation that is locally convenient.

To return to the wider topic with which this section began: the 'appreciation' of the terrain (to borrow a useful military term) as the basis for ancient settlement. It will be appropriate here to note that air study is not without value even for sites of palaeolithic date or type. Chombart de Lauwe's<sup>1</sup> oblique photographs (with interpretation sketches) of the famous Roche de Solutré helpfully and freshly display the relation of the implement-bearing deposits on and below the cliff to the local geological setting. This is, of course, a matter of demonstration and not of discovery; but in more un-charted regions, terrain study from air photographs can in fact lead one, indirectly, to the location of cave shelters, or, to be more accurate, to the points where they are most likely to be found. This point has been well put by J. Y. Claes.<sup>2</sup> In limestone regions of Indo-China, 'les chaînes calcaires abritèrent les civilisations bacsonienne et dongonienne. Un ruisseau à proximité, une plaine autrefois fertile, et surtout un cône de déblais comme on en trouve dans presque toutes les stations préhistoriques, laissent facilement supposer un lieu d'élection choisi par l'homme des cavernes.' An important practical contribution on these lines was that made by the late P. D. R. Williams-Hunt.<sup>3</sup> During a visit to south-east Australia in 1947 he made use of existing vertical air photos (1 : 11,000 scale) to show methods by which the sites of ancient aboriginal camps along the coast could be found by locating first the topographical features which dictated their position. Those spots, where off-shore reefs and wide beaches gave the best conditions for collecting marine food, were obvious on the photos but not on the ordinary maps. A ground-check confirmed the interpretation, producing numerous finds of small stone implements at the points he selected. By narrowing the area of search, terrain study from the air can thus be a means of finding 'unseen' sites, provided certain conditions are met. In Malaya also he showed how air photos could amplify the maps in the search for sites of the local stone age by locating the outlines of ancient beach lines built up behind the modern beach. These assist the discovery of ancient coastal 'midden' sites along them, and can help to throw some light on the rate at which these beaches were built up.

We may therefore note with some interest that, in special circumstances, air observation can even help to locate sites of such extreme simplicity as those of Palaeolithic type, the camp sites of savage hunters.<sup>4</sup> Professor van Riet Lowe<sup>5</sup> has given another instance, from South Africa, of its successful use for this purpose. On a flight over the Transvaal he recognized a marking of distinctive appearance,

<sup>1</sup> *Photographies Aériennes*, figs. 63-7.

<sup>2</sup> *Bull. Ecole Française d'Extrême Orient*, 1947-50, fasc. 1, 92 seq.

<sup>3</sup> *Antiquity*, 1948, 103-5 and pl. III.

<sup>4</sup> Cp. air view demonstrating the siting of Mesolithic settlements along an extinct river channel in Cambridgeshire; *Proc. Prehist. Soc.*, 1955, 3-20.

<sup>5</sup> Quoted by Crawford, *Archaeology in the Field*, 264.





11. DUNLUCE CASTLE, ANTRIM, NORTHERN IRELAND. An example of the use of shadow relief in mapping low earthworks under grass. A large area covered by the straight lines of buried medieval buildings and enclosures can be seen between the coastal road and the castle ruins on the cliff jutting out into the sea. Scale enlarged to 1 : 2,500; i.e. 1 inch equals 208 feet. See p. 35. *Crown Copyright Reserved.*



12. SOUTH GERMANY. An example of how a light fall of snow can outline minor earthworks and details of small relief. A and B: Snowdrifts reveal the slightly sunken lines of four old roads (now covered by fields) which formerly radiated from the village on the right. Snow-marks show that in area C the strip-fields originally followed a different alignment, and lay obliquely to the present divisions; snow collected in the remains of the parallel inter-strip ditches of the earlier layout, not yet completely levelled. Similar evidence for a change of layout can be seen in the bottom left-hand corner. See p. 44.

*Crown Copyright Reserved.*





13. MACEDONIA, west of SALONIKA. This vertical photo has been chosen to illustrate the total replacement of an old traditional field-layout by a new one, giving an unusually clear demonstration of 'archaeology in the making'. (A) The old irregular pattern of small rectangular fields, abandoned and grass-covered but with their boundaries still visible above ground as white soil-marks. (B) An area partitioned not long before the photo was taken in 1944. Buried traces of the old fields still show as crop-marks. The village of Adendron is on the left. (C) In surrounding areas the regular field and road pattern has already removed most traces of the old in the course of a single generation. See p. 45.

*Crown Copyright Reserved.*



14. CENTRAL ITALY: south of Etruscan and Roman Veii. This vertical photo demonstrates the important fact that the marks of buried archaeological sites are often found among others of a natural origin, and must be separated. It reveals (A-B) the course of an ancient buried track as a dark line (grass-mark, soil-mark, and gulley) leading from Veii to cross the Via Cassia. This buried track was very possibly one of the earliest of those which radiated from the site. But the numerous *curvilinear* lines of soil-marks, typical of this region, are produced by ploughing the edges of superimposed geological strata. When seen singly, they could form a possible 'source of error'. See p. 48. *Ph.* 1 June, 1944. *Crown Copyright Reserved.*



and a ground-check confirmed that it was, as surmised, a large tool-makers' 'floor' of the African Middle Stone Age. Such sites invariably occur, he explains, in cream coloured (calcified) or reddish-brown (ferruginised) subsoils, and these are being exposed by the sheet erosion of the top soil, causing sharp colour contrasts with their surroundings when the grass is green in the rainy season. That use can be made of terrain study from the air in reconnaissance for similar sites in Libya and other parts of North Africa is well-established. Miss Caton-Thompson boldly and successfully proved this when exploring the 1,800 square miles of her archaeological concession round the Kharga Oasis. Lady Bailey piloted her (having flown out from England in her Puss-Moth), and in addition took an excellent series of oblique photos<sup>1</sup> from 3,000 to 4,000 feet. Only ten days of air reconnaissance sufficed to produce results described by the report as 'of great value both geologically and archaeologically'. In the first place, a good working knowledge of the physiography of the region was obtained. More particularly the method was useful in mapping the mounds, resembling small craters, which in Pleistocene times had been the sites of springs. Field-work showed thick concentrations of stone implements round these 'fossil' springs, and it became important to locate them. Moreover in desert (as in other bare terrains) the value of air observation is, as Miss Caton-Thompson emphasises, not only to show where the main centres of archaeological interest lie, but also where *not* to look for them.

Her conclusion is that it 'eliminated, for one reason or another, large tracts of our concession as useless for our purpose, thereby saving weeks of futile ground work'. For any similar expedition this is a point of major importance.

#### SOURCES OF ERROR

After all that has been set out above concerning the many-sided details of ancient landscapes in and on the ground that await record, the moment has come to sound another word of caution on the misleading cases. The ability to distinguish the evidences of markings due to natural causes from the activities of man is particularly needed when using vertical views. Consultation of such photos is increasing so rapidly that it is desirable to mention some typical pitfalls. The examples that have been chosen, illustrated on Plates 14-15a, are by no means the most deceptive that I could have shown. There are others, undoubtedly non-archaeological, that would look too dangerously like genuine sites if taken out of their environmental context. Markings caused by buried sites are often found to be mixed with others caused by modern cultivation, etc., and care is required to separate them. An example of this, from near *Durobrivae*, has already been discussed (p. 22 and Plate 4b). Unless one is thoroughly familiar with the

<sup>1</sup> For air views of prehistoric and historic sites see G. Caton-Thompson, *Antiquity*, 1931, 221 and pls. I-VIII; *Kharga Oasis in Prehistory*, 1952, p. X and pl. 114; also *The Desert Fayum*, 1934, vol. II, pls. LXXVIII and CIII.



air archaeology of a region, it is wise to begin with the presumption that markings are 'innocent' until they can be shown to be 'guilty' of an archaeological origin.

Let us glance at some of these deceptive features. Round Rome, and elsewhere, cultivation and erosion have exposed the edges of the geological strata which lie superimposed in horizontal layers, and this produces markings which follow the contours (Plate 14). If casually examined, they might suggest the soil-marks of levelled enclosures (cp. those in Chapter 2). Obviously, however, they are too ubiquitous to represent genuine sites; separate, isolated cases have been known to raise greater doubts, but not for long. Extra care is required when a genuinely archaeological marking occurs among a much greater number due to natural causes. Plate 14 also provides an example of this. Crossing the photo diagonally is a dark line (A-B) representing the course of a buried ancient road, made visible by a soil-mark. The photo was taken on 1 June 1944, and the area lies very close to Veii. The dark soil-mark is typical of the appearance of a number of other buried ancient roads which I have located in Central Italy.

This trackway must have been of importance. It crossed the line of the Via Cassia about 14 km. north-west from Rome (just before the village of La Storta), and I have traced its buried line (bordered by débris of Roman buildings) for 1½ km. north-north-east from this point, past the farm of Casale del Pino, towards a gate on the south side of Veii,—that great city and paramount centre of the Etruscans which Rome eventually succeeded in destroying and later re-colonised under Augustus. Plate 14 is an enlargement from a print of 1 : 13,000 scale,<sup>1</sup> and incidentally it gives a good example of the value of medium-scale air photos (as defined on p. 57) for archaeological study.

In areas of land-reclamation (e.g. *bonificazione* in Italy) vestiges of modern ditches, dug a few years earlier but now levelled-off by cultivation, can give rise to crop or soil markings in straight lines with a regular lay-out. I have seen plains in the Balkans and south Europe where these, superficially, have some resemblance to the remains of the divisions in a gridded system of Roman centuriation.—but their intervals will not correspond with Roman units of measurement. The comprehensive view given by vertical photos will show the modern alignment of such marks, but cases have occurred when they have proved deceptive when they are seen on the limited area shown by a single oblique or as the result of a hasty visual impression on a commercial air route.

Soil-marks are less precise in outline than crop-marks, and therefore can be more misleading. In central Europe (notably Germany), in England, and wherever ploughing is extensive, the sub-soil is often brought to the surface by cultivation and thus produces light-toned soil markings which, considered individually, can closely resemble levelled tumuli. Plate 15a shows an instance from inland in Apulia:—the small natural knolls with their tops ploughed away, near the bottom edge of the print. There are many markings on this photograph

<sup>1</sup> Print 3137 of sortie 5 CM 719. This road was also observed by Mr. J. B. Ward Perkins when using prints of other sorties for the study of roads round Veii; *Papers of the British School at Rome*, 1955, 56 and fig. 1.



but all are non-archaeological.<sup>1</sup> The tops of old sand-dunes still more resemble levelled tumuli, but these can immediately be eliminated by their local situation. Ploughing on the edge of slopes can produce a soil-mark that follows the contour, looking perilously like an enclosure or even levelled hill-fort. The stereogram on Plate 15b gives an example of this and also of the value of stereoscopy, for on a single print it would be difficult to say whether the oval outline is a hill or a hollow.<sup>2</sup>

A ground check will often remove all doubt quickly, but it is impossible to visit every point, and therefore it is important to be able to identify and reject by photo interpretation the vast number of unimportant details.

The regular patterns made by ploughing and harvesting, and signs of the ordinary processes of agriculture (threshing floors, fodder scattered for animals, the neatly grazed circles produced by tethered animals, etc.), become familiar. As for the irregular patterns made by Nature,—old watercourses (e.g. the 'roddons', natural drainage channels in the Fens),<sup>3</sup> crop-markings above fissures in gravel subsoils,<sup>4</sup> and fungus-rings in grass,<sup>5</sup>—all these should present little difficulty. The aerial appearance of the various modern methods of land-utilisation in Europe<sup>6</sup> quickly become familiar. In Africa and Asia, on the other hand, one comes across odd and unfamiliar patterns caused by vegetation or geological strata which require some little care to identify and explain satisfactorily.<sup>7</sup>

## METHOD

We now turn to the practice of photography and interpretation, when once a zone of operations has been selected that is suitable in its ecology (i.e. subsoil and surface conditions) and in archaeological potential, known or suspected. To illustrate technique, the selection of sites has purposely been directed outside the centre of the Mediterranean world which receives attention in the following chapters, and instead the examples have been taken from its margins and approaches in the Near East. The borders between the two, so loosely drawn by geography and man, have never formed a static threshold but rather a zone of

<sup>1</sup> Including friction-scratches on the negative, white or black 'hair' lines; when faint and parallel they have been mistaken for ancient cultivation. Stereoscopic examination of consecutive prints removes all doubt.

<sup>2</sup> It is a low hill, crossed by modern cart-tracks (not crop-marks).

<sup>3</sup> Cp. vertical air photo, *Proc. Prehist. Soc. of East Anglia*, VI, ii, pl. XXXIV. Their meandering courses remain very clear as crop-marks or soil-marks after they have been levelled by ploughing. H. Godwin, 'The origin of Roddons', *Geogr. Journ.*, 1938, January-June, 241.

<sup>4</sup> E.g. *Oxoniensia*, 1943-4, pl. XII and p. 83, at Great Milton. Such markings, thought to be due to cracking during ice-age conditions, are also found in East Anglia. Their rambling lines resemble irregular field-boundary ditches.

<sup>5</sup> E.g., *Wessex from the Air*, pls. XXV and L; *Air Ph. for Arch.*, pl. III.

<sup>6</sup> See illustrations in F. Walker, *Geography from the Air*, 1954.

<sup>7</sup> Cp. W. A. Macfadyen, *Geogr. Journ.*, 1950, July-Dec., 199-210, for examples of remarkable regular patterns of natural vegetation in the semi-deserts of British Somaliland; with air photographs.

ceaseless contact to and fro. Further, it is a good thing from time to time to take the Asiatic scene as a scale and yardstick of human endeavour and to contrast its sites with those in Europe. It is sobering to reflect that while *Londinium*, the largest city in Roman Britain, measured just over one mile across, the central boulevard of ruined Samarra (Plate 17) ran for twenty miles before emerging into open countryside! The aerial study of ancient topography in Asia and Africa, as well as in Europe, is a sound way of keeping this sense of proportion clearly in view.

#### *a. Obliques*

Air archaeology has two prime tasks, (i) to locate new sites and to make manifest known remains, (ii) to map them detail by detail. In the first of these, oblique views have a special place; their merits are so obvious that illustrations like Plates 17 and 18 short-circuit further comment. But those that are published have been through a process of selection, the survival of the fittest; in practice there is always one position for an oblique photograph that is better than all the rest, and which can be determined only by circling the site. When the sun is low, crop-marks and soil-marks are usually best seen when looking at them *with* the sun. But *against* the sun is normally the right view when photographing shadow-sites, unless the highlight reflected off the banks is the chief feature, in which case it becomes necessary to view them *with* the sun. It is agreed that a flying height of about 1,000 feet is best for general purposes, using air cameras of 5 to 10 inch focal-length (p. 54). In Syria, Poidebard recommended an altitude of 300-400 metres for ordinary uses; experience has shown the same in south-east Asia and in Persia, and in South Italy Williams-Hunt and I used an altitude of 1,000 feet with an 8-inch camera as the basis of our oblique photography. Much depends on the nature and size of the sites. In Persia, Schmidt, with a 10-inch camera, regularly went up to 700 metres in order to get comprehensive obliques of big sites, and even up to 1,500 metres for the best pictures of ruined cities in relation to their setting. Williams-Hunt, and Groslier too, did the same in south-east Asia,<sup>1</sup> where the remains of ancient landscapes survive to the same majestic extent. One must bear in mind that the focal length plays as big a part as the flying height in determining the scale of the photographic image, and, *à propos* of scale, it is essential to manoeuvre all small sites into the immediate foreground of the picture (in taking obliques one notes a tendency to hang back, too far off). For detail, low obliques from 300-400 feet can be very effective on the right type of site, chiefly small earth-works. Low obliques do not usually add new details that could not be seen on photographs from higher altitudes. They are merely enlargements on the spot instead of in the studio. Some crop and soil sites are unsuitable,—the effect

<sup>1</sup> Likewise V. Goloubew, in his archaeological reconnaissances in Cambodia, usually flew at 1,000 to 1,500 m. to find his way about and to pinpoint the position of his obliques in confusing and badly-mapped country; *Bull. École Française d'Extrême Orient*, 1936, 465-77.



of such enlargement is only diminished definition. To illustrate this, Poidebard describes the occasion when he was taking obliques of the ancient route that ran from Palmyra to Hit, which was visible only in the form of weed and soil marks. He observed that it could be seen clearly from the air down to a height of 300 metres (c. 1,000 feet), but that below this height the course of the road progressively grew fainter the closer he went in the hope of seeing it better! On sites consisting mainly of buildings (e.g. castles, etc.) photography from a steep angle is best. It should be noted that obliques are capable of giving a misleading impression of natural relief (e.g. when taken at right angles to rising or falling ground, they can give an effect of total flatness).<sup>1</sup>

But when skilfully positioned an oblique is unequalled for showing the way in which a site was fitted into the landscape. Plate 18 will serve as an example: the Roman road at Zairwan in N.W. Iraq, taken from 1,000 ft. with an 8-in. lens.<sup>2</sup> There was only one ideal position for the photography of such a subject,—looking down its length as it passes from the spine of one ridge and on to the next. One can instantly appreciate the tactical flair of the military surveyors in choosing the line of maximum all-round visibility against mobile forces raiding across the desert.

Pastoral nomads do not, alas, leave much archaeological litter as a rule. But the ancient landscape conjured up by this Roman road at Zairwan impels me to remark on the extraordinarily interesting contributions to the cultural ethnography of Antiquity that are made by aerial mapping in desert zones. The remains of tribal communities express visibly and tangibly a way of life and thinking fundamentally distinct from the sites which express a Classical ethos and traditions. But to come down to cases, as ethnography must:—I am thinking particularly of those areas of black basalt hills 100 miles east of the Dead Sea, which form the southward extension of the Jebel Druze.<sup>3</sup> They are literally carpeted with hill-forts, stone hut-circles, camel 'baraks', long lines of stone walls meaningless in terms of European economies but meaningful to desert dwellers, and, most prominent of all, those large kite-shaped walled enclosures called *gazalia* or *mesayid*. These last are still used during gazelle *battues*, but their specialised shape may have been evolved originally for a different purpose, e.g. the protection of tribal herds. Many of these extensive remains of a tribal landscape lie cheek by jowl with Roman military posts and are certainly their contemporaries,—the works of semi-pastoral tribes more or less auxiliaries of the

<sup>1</sup> For example, one would never gather from Major Allen's otherwise excellent oblique of Celtic fields on Burderop Down, Wilts., that they lay on a steep hill-side,—an essential point in the formation of lynchets, see *Geogr. Journ.*, 1945, 52, plate V; *Discovery from the Air*, pl. 28.

<sup>2</sup> R.A.F. photo of 24 March 1938; c. 60 miles west of Mosul, in the Sinjar range and not far from the site of Singara.

<sup>3</sup> Cp. F/Lt. Maitland, *Antiquity*, 1927, 197 seq. and plates, on the 'Works of the Old Men' in Arabia; and Group Capt. Rees, V.C., *ibid.*, 1929, 389 seq. and 9 plates, 'The Trans-Jordan Desert'. These remarkable small-scale vertical air photos give a taste of what a systematic survey could produce. See also Poidebard, *La trace de Rome dans le désert de Syrie*, 194 seq., and pls. XIV and CXLVII, 'enceintes des partisans nomades'.



Roman army of occupation, but retaining indigenous habits. It was a situation of 'culture contact',<sup>1</sup> as anthropologists phrase it, not unlike that of the North West Province of British India in the 19th century. The Roman constituents of the landscape are a good deal easier to analyse than the tribal ones which tend to be passed over, although Poidebard devoted some of his field-survey to them. But it is much to be hoped that the 'Works of the Old Men' will attract a detailed investigation<sup>2</sup> before they or we are much older. It is a field in which archaeology and ethnography could well combine, for the comparative study of past and present tribal life helps to an understanding of both. Such is desert conservatism that some of these sites continue to be re-occupied periodically at the present day.

The panoramic view is the perquisite of the oblique, the planimetric of the vertical<sup>3</sup>. It would be hard to find an ancient landscape more evocative from both points of view than the ruined metropolis of Samarra, 65 miles NNW. of Baghdad. The panoramic oblique on Plate 17 (taken from 1,000 feet with a 24-inch lens) includes no more than a very small fraction of the whole site, even though it shows the remains of streets stretching mile upon mile into the distance. Yet its life-span as a prodigious capital falls within 50 years, the perfect example of those 'despot' cities, built or abandoned at a despot's whim, of which Asia can boast such a remarkable series:—the Delhi sequence for example, or the successive foundations at Sian-fu (Chang'an) and many other ancient cities of China and south-east Asia. It was in A.D. 836 that the Caliph Mu'tasim, son of Haroun al-Rashid, moved his capital from Baghdad to its new site at Samarra, creating a more grandiose city than ever any Roman Emperor did. Wide intersecting avenues, palaces, barracks, race-courses, and a stupendous canal whose banks rise like hills along either side, were disposed up and down the east bank of the Tigris for nearly 25 miles by Mu'tasim and his successors. Of these buildings, one of the most notable is the mosque, with the minaret called Malwiya (Plate 17). After those of Kufa and Wasit this mosque is the

<sup>1</sup> All marginal regions can, or could, provide comparable traces: cp. Sir Mortimer Wheeler's *Rome Beyond the Imperial Frontiers*. In several parts of the Roman periphery, field archaeology has been much assisted by the aerial mapping of sites; cp. O. G. S. Crawford's comments in *Topography of Roman Scotland north of the Antonine Wall*, 1949, p. 2, on the clash of opposites shown by the rigidly planned sites of the conquerors and the less formal habits of the barbarians:—'On an air photo it is, in fact, as easy to distinguish characteristic Roman from native earthwork as it is to tell a Bronze Age beaker from a Samian bowl'. *A fortiori* the same would apply in Spain and Portugal, and Anatolia. For the *Limes Tripolitanus* frontier in Libya (the mapping of whose settled areas was materially aided by R.A.F. sorties), see Ward Perkins and Goodchild, *J.R.S.*, 1949, 81 and 1950, 30. On this and other frontiers many de-tribalised people were serving as *limitanei*. Ethnically, of course, the inhabitants on both sides of a *limes* were usually akin.

<sup>2</sup> Such study should also take into account the extensive remains of the field systems on the desert margins, traced from the air and on the ground in the Negeb and in Trans-Jordan by Wiegand, Glueck and others; for references see O. G. S. Crawford, *Archaeology in the Field*, 1953, 213; *Antiquity*, 1954, 206, pls. IV.-V.

<sup>3</sup> Oblique photography of excavations in progress have rarely been of more than scenic value; for experimental verticals with a camera attached to a captive balloon, taken for planning during the excavations at Megiddo, cp. *Antiquity*, VI, 148-55; pl. XVI, 465.



oldest in Iraq and its plan,—a great rectangle with buttressed walls,<sup>1</sup>—is of interest for its early simplicity. The spiral minaret, too, is a curiosity. It has been pointed out, by Seton Lloyd and others, that there was at this time little precedent for what a minaret ought to look like, and it would seem that the form of this minaret (and of a second spiral one at Abu Dulaf in another part of Samarra) may have been suggested by the *ziggurats* or staged towers, which were already relics of a remote antiquity. Babylon's ziggurat, for example, is known to have been still standing when Samarra was under construction.

In describing Samarra, it would be easy to exhaust one's adjectives. The scale and symmetry of the extensions added by successive caliphs are of proportions that are almost unequalled, 'resembling in conception the wildest flight of fancy on the part of a modern fifth-year student of town-planning at the Beaux Arts or competitor in the Prix de Rome'. To meditate on these remains, so patently visible on vertical surveys, is to delve deep into the vanity of government and power; indeed, the prolonged study of ancient topography develops its own train of philosophical reflections. In spite of, or because of, its overwhelming size and admirable preservation, the skeleton of the 'mushroom' city of Samarra is a sombre spectacle. Towards the end of the 9th century, the dynasty returned to Baghdad and the entire city gradually fell into decay (some quarters had already been abandoned during its febrile growth). A hundred years later Arabic historians were writing of Samarra in the past tense, though a little life lingered in the extremities when the trunk was stilled. Combining the detailed description by Ya'qubi, who wrote in *c.* 889, with the data from vertical air survey, the plan of the city can be ascertained with extreme precision. And, in spite of all the labours of Viollet, and of Herzfeld, there is still much scope for aerial mapping on this site.<sup>2</sup> Many smaller mounds which acquire clear and intelligible outlines from the air are infinitely less obvious on the ground.<sup>3</sup>

Brief reference should be made to mechanical devices which enable measurements to be calculated with accuracy from *high* oblique photos. One of these is the 'Photoblique Plotter', 18×18 inches in size. After suitably positioning the print, the data which can be determined include (i) ground distances, (ii) area measurements of any regular or irregular surfaces. The U.S. Geological Survey is also now mapping by means of twin low-oblique photography. I mention these specialised methods only in order to emphasise the intense activity in improve-

<sup>1</sup> It was surrounded by an outer enclosure wall, whose east side can be seen on the left of the photo, with part of the west side in the right-hand corner.

<sup>2</sup> O. G. S. Crawford published a portion of a fine R.A.F. photo-mosaic that mapped Mutawakkil's palace, in *Geogr. Journ.*, January-June 1929, p. 500. Herzfeld, in *Die Ausgrabungen von Samarra*, vol. VI, published in 1948 five mosaics from photos taken in the 1930's, which covered the greater part of the city. This was a brave attempt, though marred by excessive contrasts of tone on adjoining prints, so that many areas are lost in blackness. Outside the southern limits of Herzfeld's mosaics there lies a large complex of buildings called al-Musharrahār, and other remains; I have now obtained photos of this area.

<sup>3</sup> Cp. ground views of site, Herzfeld, *op. cit.*, pls. IX-XV. See also *Excavations at Samarra*, 1936-9 (2 vols., Directorate of Antiquities, Baghdad, 1940) and Seton Lloyd, *Ruined Cities of Iraq*, 3rd ed. 1945, O.U.P.



ments of aerial techniques. But for archaeological mapping, normal vertical survey still cannot be improved upon.

*b. Photographic apparatus*

If no air camera is available, it is possible to take oblique photographs with a pocket one of 'Leica' type<sup>1</sup> that will be adequate for record purposes and will control the visual memory, very fallible and selective in what it chooses to recall. Useful discoveries have been made in this way. But there is a set limit to the resolving power of any small lens, and to what can be extracted from the grain of any film by enlargement. Air cameras with a lens of 8 to 10 inch focal length are sufficiently powerful for oblique work; larger cameras are inconvenient if hand-held. Ex-R.A.F. air cameras of excellent performance were available at a purely nominal price after 1945, and I found no difficulty in obtaining two. Crawford and Keiller used a captured German 25 cm. (c. 10 inch) camera with a f. 4.5 Zeiss Tessar lens; Schmidt in Persia used a Zeiss camera of the same size, rejecting another whose focal length was too short, causing blurred edges on the prints. The British 'F. 24' with interchangeable lens (from 3 to 20 inches) is as good as either of these; its negative is 5 inches square, with 100 or 250 exposures in a roll. But whatever choice is made, a lens of sufficiently wide angle is a prime necessity. Details of the constant improvements in air cameras, camera mountings, etc. can be obtained from any professional firm.

With obliques we can consider single verticals, both part of the technique of reconnaissance from light aircraft, as distinct from systematic coverage of large areas by aircraft with built-in cameras making automatic exposures. The most suitable type of light aircraft to use is a high-wing monoplane like the 'Fairchild'; low wings obstruct the view. By steeply banking the aircraft, there is no difficulty in taking near-verticals with a hand-held camera (cp. Plate 3); the late Major Allen even managed to take near-verticals when flying solo, joystick held between the knees. His Puss Moth was a very stable machine which could safely be left to fly itself in calm air. It is noteworthy that sunny days which would otherwise be ideal for photography are often bumpy, and the hotter the day the more troublesome this may become.

True verticals can, however, be taken from a light aircraft, and 'sighted' through a glass or perspex panel. Schmidt used the 'aerotopograph' device. This was a suspension mechanism fixed to a hole in the floor of the aircraft and carrying the camera. A telescope, with its axis parallel to that of the camera, is attached and with its help one watches for the exact area and the critical moment for photography. Drift, from cross-winds, is corrected by a movable disc supporting the camera. By means of three screws the whole device is

<sup>1</sup> Best mounted on a hand-grip and operated by a flexible cable release, improving sighting and reducing vibration effects. The cost of such 36 mm. photography is much less, opening the whole field of discovery to members of flying clubs; cp. 'Archaeology from the Air: a rewarding pursuit for the private pilot', by A. W. Baker, *Flight*, 19 February 1954.



adjusted to a horizontal position defined by levels in the telescope and on the camera. Precision is important, as such photos will be used in survey work. The advent of the helicopter as an all-purpose machine, instead of the rare creature it used to be, will make things easier. But in helicopters, at present, vibration is still something of a problem.

It is to be regretted that publications on air archaeology often omit to mention the photographic factors which were found suitable or unsuitable. My own experience is that the following factors give good results on a sunny midday of average visibility in England, when taking single verticals or obliques:—

f. 8 1/300 sec; 5-inch F.L. lens.  
or f. 5.6 1/300 sec; 8-inch F.L. lens.  
Film: Super-XX Kodak. Filter: Deep yellow.

This is no more than a guide,—speeds as slow as 1/150 sec. are possible in steady flight. The factors above would have to be adapted to suit slower film, and the aperture would be increased in early morning or evening.<sup>1</sup> The use and choice of filter is important, to combat haze and to emphasise tone-contrast on crop-sites. Crawford and Keiller, in their flights, used an ordinary yellow filter (Ilford 'Minus Blue') for general purposes, but mention that a stronger filter (e.g. Ilford 'Furniture Red') would have been useful if the morning and evening sunlight in that bad English summer during 1924 had ever been bright enough. Various experiments have been made with roll-film whose emulsion is sensitive to infra-red light, and with colour-photographs (both transparencies and prints). These heighten the effect of tone-contrast, often to a dramatic degree. As regards colour, the negatives (if not too dense) can be used to make good lantern slides; such photographs will not normally show archaeological features that would be invisible in monochrome. A few examples could be produced where colour has been essential in identifying significant features. But it is more rewarding to concentrate on regularly obtaining first-class photos in monochrome.

Because 'infra-red' film is sometimes regarded with a vague awe, a further word is needed about its use. The results are predictable and have been used with profit in ecological survey work from the air (especially in forestry) for a number of years. As far as concerns archaeology the principles, in brief, are as follows. The colouring of vegetation, as seen by the human eye, is due largely to the presence of chlorophyll in the structure of the leaves. But the reflection of infra-red radiation by the leaf has little relation to the perceived colour, being largely a property of the epidermal layers and cutin. The behaviour of these layers towards infra-red radiation is variable. Field tests have many times proved that grasses are very suitable subjects and their great infra-red reflecting power causes them to appear as a brilliant white on the print. On the other

<sup>1</sup> Major Allen, using panchromatic plates, worked with an 8-inch F.L. camera that he made himself; its 4.5 lens (generally fully open) was usually set at 1/200 sec. Schmidt, in Persia, normally gave exposures of 1/250 sec. (aperture of f. 3.5 constant) between 7 and 8 a.m., the best hour for clear atmosphere.



hand mature and drying grasses (as from parch-marks, etc.) are poorer reflectors and appear as a light grey tone. Plants, crops, etc., in their individual ways vary as reflectors according to their condition. Visually-similar colourings are hard to show with panchromatic films, which have about the same colour-sensitivity as the human eye, and there is a limit to the help that filters can give them. The photography of infra-red radiation is in fact, to a large measure, a distinct and separate way of recording the tone-contrasts which we require from vegetation markings. Correct exposures are best determined by experiment.<sup>1</sup> To the scientific tests of infra-red sensitive film in the air photography of underwater features I have earlier referred (p. 43).

In all types of photography, results will be inferior if the area is under cloud shadow.

### *c. Air Crew*

In all reconnaissance from light aircraft, taking single oblique and vertical views, a crew of three is greatly to be preferred, although sometimes space restricts this to two. When areas are being opened-up by air search there will be more than enough for a crew of three to do, as was soon impressed on us in Apulia (p. 91). Besides the pilot and the cameraman, the observer is a much needed member: he it is who pinpoints on the map<sup>2</sup> the exact location of each photo and any significant features outside the area taken, and who notes the conditions in the soil or crops, and local archaeological details. It is essential that these data be recorded with precision on map and log-book at the time of photography,—otherwise chaos will ensue when the sortie, perhaps numbering one hundred obliques, returns to base. If the landscape has few distinctive features, or the maps are dismally inadequate and new sites are numerous (a not uncommon situation in some regions), it is an undue handicap to combine photography and all the recording. One sympathises with a desperate entry in Schmidt's log-book, 'Tepes everywhere'! At such critical moments the value of vertical photography for overall coverage is dramatically emphasised. In oblique photography the pilot's attention is usually fully occupied in following the pre-arranged route and steering to individual targets.<sup>3</sup> Even when the camera is not hand-held but mounted in the aircraft, its operator ought to be enabled to give his whole attention to it. If the crew must be limited to two, aircraft in which they can sit side by side are to be preferred. In any event, it will probably require several flights before team-work and communication reach the high pitch which is required for regularly good results. If the area is a new one, visual reconnaissance from about 3,000 feet would be the first step.

<sup>1</sup> For a practical account of the use of this medium, see R. L. Ives, *Ecology*, 20, No. 3, 1939, 433-9 (esp. pl. III, tone contrasts in grass).

<sup>2</sup> Two kinds will be needed, 1/250,000 (or 4 miles : 1 inch) for planning the flight, and 1/50,000 (or c. 1 mile : 1 inch) for recording the discoveries.

<sup>3</sup> Flying on a straight course at about 100 m.p.h., at about 800-1,000 feet the cameraman has a maximum of 2 to 2½ minutes for a site to swing into view forward, to pass and to be lost to effective sight behind.



Sorties flown for the archaeological mapping of large areas with automatic cameras are a different matter. When fully briefed the pilot can fly unaccompanied.

*d. Verticals: calculation and choice of scales*

It would not have been difficult to fill this section with tables of figures. 'Long and painful experience has taught me one great principle', once wrote G. L. Dodgson (Lewis Carroll), 'if you want to inspire confidence, *give plenty of statistics*. It does not matter that they should be accurate or even intelligible so long as there is enough of them'.<sup>1</sup>

Fortunately, the numerical details can be reduced to the simplest terms. When we turn to true verticals, either single exposures or consecutive series taken automatically, our first concern must be that of photographic scale:—how to calculate it and what to expect from large, medium, or small. Stereo prints up to about 1 : 7,000 will be rated as large-scale, from 1 : 8,000-12,000 as medium, and above that small.

Viewed with the strict eye of the aerial surveyor, verticals are spoiled if they have even a very small degree of tilt, distorting the edges of the prints. Happily, such standards of perfection matter less in archaeology's requirements, which are of a simpler kind. For any vertical,—let us say a typical contact print ( $8\frac{1}{2} \times 6\frac{1}{2}$  inches) from our National Survey,—the scale can be calculated by a very simple formula:—

$$\text{Scale} = \frac{F}{H \times 12}$$

where F is the focal length of the camera's lens in inches and H is the flying height in feet (an appropriate subtraction from this figure is needed in mountainous country). As far as my experience goes, this method suffices very well for general purposes in archaeological topography in most kinds of terrain.<sup>2</sup> On other pages (e.g. pp. 96 and 143) I have given examples of the accuracy of measurements obtained when using scales calculated in this way. It is, of course, an essential requirement in photo interpretation to know the amount of topographical detail that can reasonably be expected from prints of various scales. At large and medium scales objects only a few feet across may be measured satisfactorily, but at small scales they will be imperceptible, and beyond the range of definition imposed by the grain of the film. Enlargement will not produce details which can not be seen on the contact print, but it is often convenient to enlarge for purposes of reproduction.

<sup>1</sup> From the preface to *Three Years in a Curatorship*, Christ Church, Oxford, 1886. Dodgson was Curator of Common Room.

<sup>2</sup> The alternative method is to compare the measurement between two points on the photo and the same two points on the map (or on the ground when this is convenient or when in poorly mapped regions). It is best to choose two or three sets of such measurements and to take their average, if this method is followed.

The measurements of objects on the photographs are taken in millimetres and fractions of millimetres, using that type of pocket magnifier which has a scale in  $\frac{1}{16}$  of a millimetre engraved on glass beneath the lens. With practice and care, the taking of such measurements presents no difficulty. A book of photogrammetric tables, which is a 'ready reckoner', will then give the equivalent distance in feet on the ground at any fixed scale; for example 6.6 mm. on a photo with a scale of 1/6,000 equals 130 feet on the ground. Much of Baradez's excellent interpretation of Roman defence lines in Algeria was done from photos taken from 13,000-16,000 feet, on which measurements of  $\frac{1}{4}$  and  $\frac{1}{2}$  millimetre represented linear earthworks 10 and 20 feet wide. The crop-marks of Roman vine trenches which I have mapped in Apulia were often represented by lines only  $\frac{1}{16}$  millimetre thick on the photograph. But, as when working with a microscope, one is soon accustomed to a small world! If the edges of the object are well defined the margin of error from all causes should, if care is exercised, be not more than 5 per cent., but precision is restricted when measuring objects less than 5 feet across. Accuracy is aided by instruments which will measure the distance between two image points on a photo to one ten-thousandth of an inch.

Photographs intended for stereoscopic examination are best taken at heights of 5,000 feet upwards. Their scale will, however, depend *as much* on the focal length of the lens as on the flying height. Thus a 36-inch lens from 30,000 feet and a 6-inch lens from 5,000 feet will both provide contact prints of 1 : 10,000 scale (roughly 6 inches to the mile). Crop-markings, it should be noted, are clearly visible on photos taken from heights of as much as 3 or even 4 miles; very detailed interpretation has been done from clear photos of 1 : 10,000 scale in Apulia and Etruria, and its precision has been proved on the ground. For Roman land-partition based on large square units (*centuriae*) in Europe and North Africa, and for topographical work on Roman roads, scales of about 1 : 7,000-10,000 will do very well; larger scales may actually be inconvenient, requiring too many photos and showing too little of the lay-out on each. For the general view needed at the start of the study of such extended remains, photos which cover a big area at a small scale (1 : 15,000-20,000) are exceedingly useful. Scales between 7,000-12,000 are suitable for the study of the plans of living towns. For detailed work on complex crop-mark sites about 1 : 6,000 is, in my experience, a very satisfactory scale, especially since the stereoscope's magnification enlarges this two or three times for the viewer. Photography with a 14-inch lens from 7,000 feet will conveniently give prints having this useful scale. It would be appropriate for the mapping of large areas of ancient fields, prehistoric or Roman, European or Asian, and their attendant settlements. It is the suitable method for the 'family group' so to speak, distinct from the 'portrait study' of one small area taken vertically at 2,000 feet or less. But it should not be thought that much smaller scales are incapable of giving photographs that would be hard to improve upon for archaeological value. Examples are legion and it will be



enough to mention two: an outstandingly good R.A.F. photograph of 'Celtic' fields on Windmill Hill<sup>1</sup> at 1 : 15,000 scale (8½-inch lens at 10,000 feet), or the equally good vertical of the zone of minor earthworks which is all that is left of the site of Old Basra,<sup>2</sup> taken by the R.A.F. in 1919 at a scale of 1 : 12,000 (8½-inch at 8,000 feet). One cannot have too many of such views as these.

Another matter of practical importance is the coverage, or area of ground represented by each print. Suppose we take three photos: the first with a 20-inch lens at 10,000 feet, the next with a 14-inch lens at 7,000 feet, and the last with an 8-inch lens at 4,000 feet. In all three cases the scale will be the same (1 : 6,000) and the side of a 7 × 7-inch contact print will cover an equal distance on the ground, about 1,160 yards. From this it will be seen that it is more economical, for coverage, to fly higher and use a camera of longer lens. In the small regional landscapes of British archaeology (already well explored) such a point matters less than in regions overseas that are being reconnoitred aerially for the first time and may contain 'empty quarters'. But in the choice of flying height a good deal will depend on the atmospheric conditions likely to be encountered. To simplify matters, there are charts which calculate the exact number of exposures that will be required to photograph a given area at any scale.

A useful new development in recent years has been 'continuous strip' photography, with continuous-running film exposed in conjunction with a shutter. This special application of air photography is for use with low-flying aircraft.

#### *e. Stereoscopy*

Probably the most important technical development in air archaeology is the increased availability and use of vertical photographs that can be examined stereoscopically. 'Increased' is the operative word, for suitable photos have been available to British archaeologists ever since the first world war, when stereo work was a normal part of military air photo interpretation. But until the close of the second world war there were very few references in archaeological publications to the advantages of this method of study. In this matter, some geographers and geologists were certainly ahead.

Admittedly, some little extra trouble is needed to take such photos for oneself, but that practical matter was overcome by some determined archaeologists.<sup>3</sup> If one has access to a professional photographic-reconnaissance aircraft such problems of make-shift naturally do not arise. It is then merely a routine matter of navigating sufficient parallel strips to cover the area desired, with automatic exposures along a set course. The archaeologist's chief concern will be to decide the appropriate season and the photographic scale required, basing his plans on his assessment of the archaeological potential of the region. The procedure

<sup>1</sup> Crawford, *Air Ph. for Arch.*, pl. IX.

<sup>2</sup> *Id. Geogr. Journ.*, LXXIII, 1929, January-June, pl. facing p. 507.

<sup>3</sup> For one method advised, see p. 54.

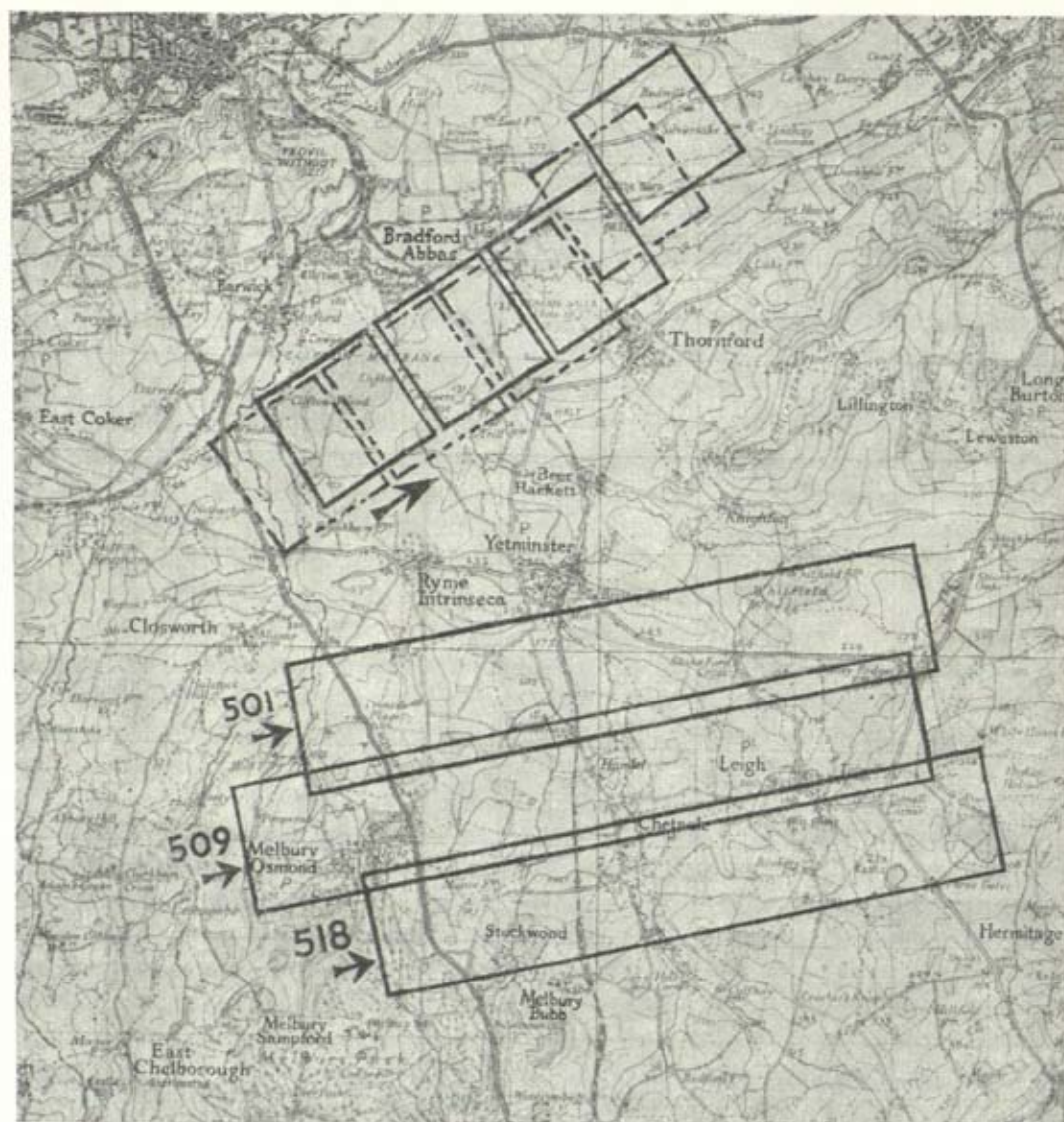


FIG. 3 *Above.* A series of 8 vertical photos taken for stereoscopic study; in practice, there would be a 60% overlap between consecutive prints. In this example, each print covers an area of  $1,500 \times 1,500$  yards. This is the coverage given by a  $7 \times 7$  inch negative from an altitude of 9,000 feet, using a 14-inch F.L. lens. Scale of photos will be  $1 : 7,714$ . The last two photos show how 'drift' can be caused by strong winds, etc. *Below.* The normal method of plotting vertical photos for reference. Three 'runs' of 8, 9 and 8 prints from a typical 'sortie'; data as above.

Base map reduced from O.S. 1 inch to 1 mile, sh. 178 ( $1 : 63,360$ ), N.W. Dorset : area Bradford Abbas—East Coker—Ryme Intrinseca—Melbury Bubb; by permission of the Director-General, Ordnance Survey. (*Crown Copyright Reserved.*)



will not differ in any essential from that of the countless sorties flown by commercial companies every day, in various parts of the world, in the course of mapping, etc. The pilot will not search for the sites visually,—if they are visible they will appear on the photographs. In this methodical manner there will be no zig-zagging from site to site, leaving blank areas to be photographed 'one day',—often never; it is not only a matter of much greater and more economical coverage of land-surface, but certain kinds of archaeological distribution demand this method. How else, for example, could the details of the square miles of Roman agricultural systems in Apulia, preserved *only* in crop-mark form, have ever been mapped? One must reckon with the fact that non-specialists will prefer low-level views of individual sites specially posed: and the specialist, too, will be glad of them later when presenting the evidence. All this, however, amounts to no more than a simple choice of tool.

Nor is the practice of stereoscopic study difficult in itself; its principles, applied to ground photos, made one of the polite amusements of the Victorian parlour. It is, rather, the problem of communicating the effect easily in publications that tends to restrict its employment in archaeology. In terms of printing, stereograms (e.g. Plate 15b)<sup>1</sup> are reproduced like ordinary photographs, and, although they are less satisfactory when examined in the form of half-tone plates than as original photos (because of the mesh of dots), a good case could be made for including more of them in publications, when the type of site requires such illustration. Their drawback is presentation, not use. *A propos* I shall quote some conclusions of Dr. Daniel's: 'The use of anaglyphs<sup>2</sup> and vectographs for illustration gets over this difficulty in part, since anaglyphoscopes and polaroid viewing spectacles can be more easily enclosed in books than lens stereoscopes. . . . The ideal is probably to illustrate archaeological reports and books with stereograms constructed for an average interocular distance and to assume, as the *Illustrated London News* did occasionally during the 1939 war, that every home possesses a lens stereoscope. Only then will the full uses of air photographs to the archaeologists be realised.'<sup>3</sup>

But times are changing. It is significant that Chombart de Lauwe, in his book *Photographies Aériennes*, which concentrates on archaeology and human geography, gives sixteen pages to the use of stereoscopy and includes three stereograms. If space had allowed, I would have added more to the present book. Most important of all is the training of archaeological students in this method

<sup>1</sup> This stereogram has been described on p. 49. It would have been easy to take the example from mountainous terrain in which the stereoscopic effect of heights would have been more dramatic. But I have deliberately chosen an area where the relief is less obvious, but is the vital factor in the problem discussed.

<sup>2</sup> Consisting of two consecutive vertical photographs each printed in a separate colour, superimposed one on the other; spectacles with a lens of each colour must be used with them. Examples were included in *Luftbild und Vorgeschichte* (see p. 16 above, note). The stereo result is fairly good, but the technique is too expensive and elaborate. The printing of two ordinary photos in black and white is regarded as the best method available at present.

<sup>3</sup> G. E. Daniel, *A Hundred Years of Archaeology*, 1950, 302.



of work; such training should be an integral part of every systematic course. At Oxford since the war, those whom I have taught have been given individual practice with lens stereoscopes, and in lectures to groups of students use is made of stereoscopic lantern slides ('vectographs') projected on to a silvered screen, each member of the audience having spectacles with lenses of polarised material (made in the Department for a few shillings each). In this way the audience is able, collectively and individually, to see the topographical relief of sites as if suspended in mid-air above the ground. A useful book<sup>1</sup> devoted to training the eye in stereoscopy has been published by the Institut Géographique National.

Almost all the work on this book has been based on stereoscopic photographs. To those unfamiliar with their use, the matter can be explained in a few words. A continuous series of consecutive vertical photographs is required, each having an overlap of 60 per cent. in common with the next in the direction of flight.<sup>2</sup> The portions common to both are placed under the stereoscope and the twin views of the feature to be examined are arranged immediately beneath the lenses. After some practice the two images should fuse optically into one in full relief, just as they do in the ordinary binocular vision which our eyes and brain habitually supply. On Plate 16 I have shown two such photos in position for stereoscopic inspection. The site is that of Erbil<sup>3</sup> in Northern Iraq, an existing town which forms the most recent stratum to be superimposed on the top of the huge artificial mound (160 feet high) built up by successive ancient fore-runners. The stereoscope shown here is a folding 'pocket' instrument; complex kinds are also in use, but this simple type is ideally suited to archaeological study.<sup>4</sup> *In photo interpretation, an experienced eye is of greater value than elaborate equipment.* The lenses (magnification  $\times 3$ ) are adjustable to fit the interocular distance between the viewer's eyes, normally about  $2\frac{1}{2}$  inches. The stereoscopic impression of the earth's surface which is received is, in effect, that which would be obtained by a giant whose eyes were as far apart as the distance travelled by the aircraft between successive camera exposures,—one or two hundred yards. To complete the examination of the 60 per cent. overlap, before proceeding to the next, it is usually necessary to raise the edge of one print and readjust the pair closer together, in order to avoid folding. The prints must be examined in the order in which they were taken and in accordance with the line of flight, otherwise hills may sink into the ground as valleys, or the sea appear to hang in space!

Under this head, there is one point of detail that is of importance. When

<sup>1</sup> *Collection de Stéréogrammes* (Paris, 1947), with 54 pages of stereo pairs of air views reproduced photographically.

<sup>2</sup> Ordinarily the survey aircraft of commercial companies mount two vertical cameras side by side ('split-verticals'), which take two parallel strips of photos simultaneously, themselves overlapping slightly,—thus giving the total coverage which is required when making photo mosaics.

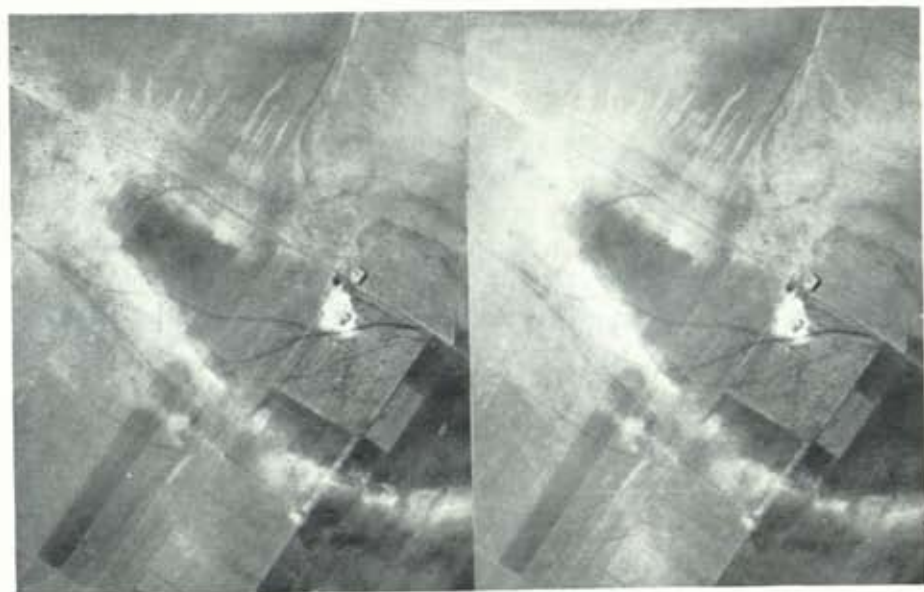
<sup>3</sup> The ancient Arbela and earlier Arba-ilu,—whose name is recorded in the third millennium B.C.—it is often taken as an example of one of the oldest continuously inhabited cities in the world. For an oblique view, *Antiquity*, 1936, 136, pl. I.

<sup>4</sup> With practice it is possible to fuse the images by eye, without a stereoscope; but this is of no use for detailed study.

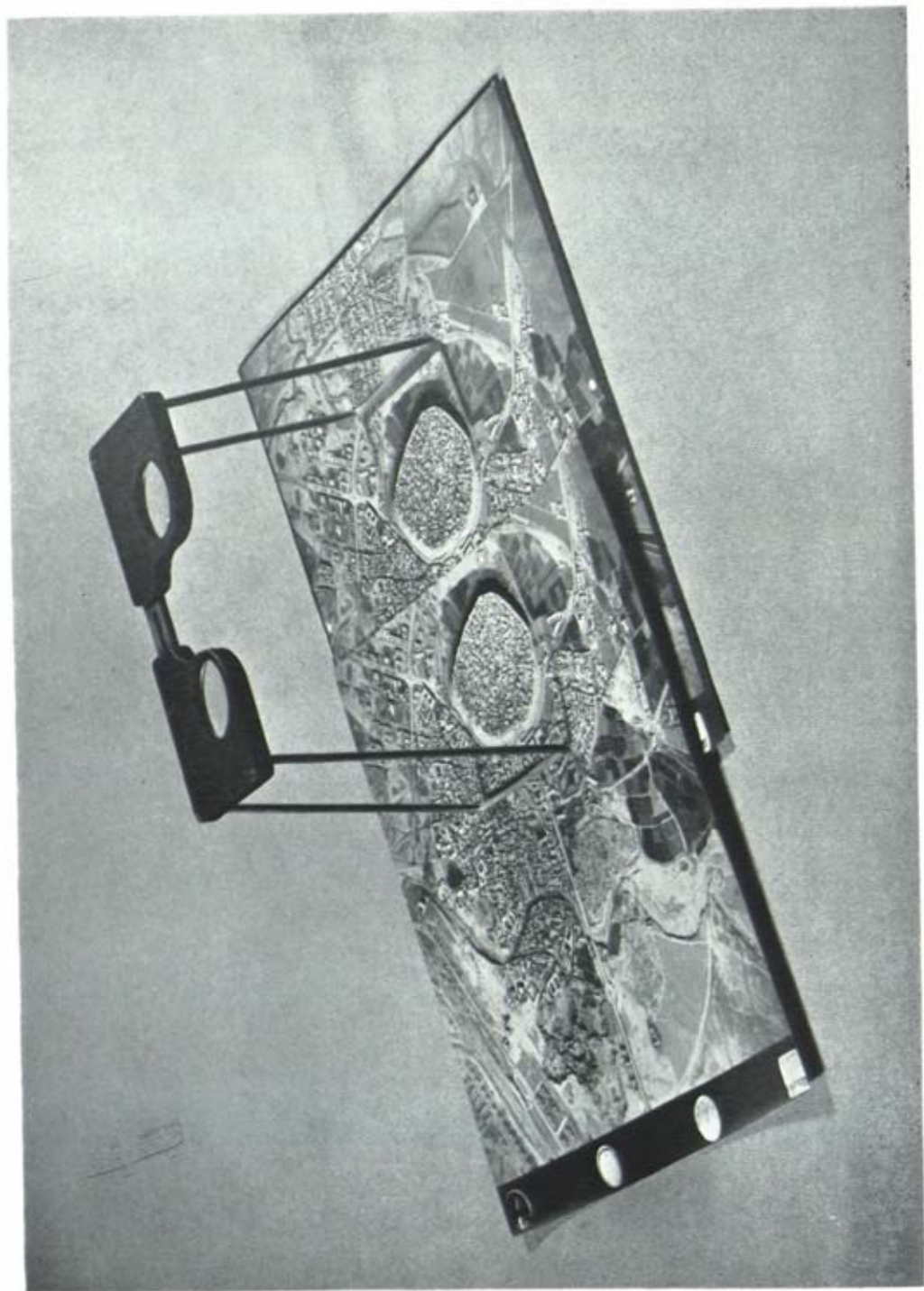




15a. SOUTH ITALY, APULIA. 'Sources of error'. This vertical view (1 : 6,000) taken on 12 July, 1945, shows many marks on the ground but all are non-archaeological. The white patches inside the circle are due to geological differences, *not* levelled tumuli; the straight parallel field boundaries are modern, not Roman *limitatio*. The straight black line in the upper left corner was made by a friction-scratch while the film was turning. See p. 48. *Ph. Bradford, June 1945.*



15b. APULIA. 'Sources of error'. Parts of two consecutive vertical photos (1 : 6,000) arranged as a stereogram. This example shows that a complete and accurate interpretation of such photos makes the use of a stereoscope necessary. For an explanation of the various marks see p. 49. *Ph. Bradford, June 1945.*



16. NORTH IRAQ, ERBIL. This illustration shows two vertical photos (taken by *Aerofilms Ltd.*) placed in position for examination by a pocket stereoscope. This type of instrument is well suited to archaeological use. The 'title strip' on each photo records the altitude, time of photography, etc. Erbil is one of the oldest inhabited cities in the world. See p. 62.





17. IRAQ, SAMARRA. An oblique view showing the remains of the chief mosque; and, in the background, shadow-relief outlines some of the straight streets in this vast ruined metropolis of the 9th century A.D.  
See p. 52. *Ph. Aerofilms Ltd.*



18. NORTH-WEST IRAQ. A Roman military road with associated structures outlined by stone walls, on the frontier *limes* in the Sinjar hills, 60 miles west of Mosul. See p. 51. *Crown Copyright Reserved.*



setting out pairs of prints for stereoscopic work, the viewer should invariably examine them with the shadows of objects and terrain falling towards him, or to one side,—never away from him. Only in this way will the appearance of the relief look natural, and not seem to lean over backwards or confuse height and depth. The same is true of single vertical photographs that are published—the print should be presented so that the shadows fall towards the viewer or obliquely to one side.<sup>1</sup> The intelligibility of the visual effect matters more than the position of the north point. Some recently published photos have been marred by the failure to observe this now accepted principle.

*f. Archaeological ground-air survey*

The practical value of air mapping in drawing-up the surveyed plans of large sites deserves further attention. In the case of city-mounds, the combination of vertical photography and fixed ground-control has unmistakable advantages over the survey draughted on the ground alone. Nor is this combined method difficult in practice. Erich Schmidt has quoted his excavations at Istakhr in Persia as an example. Here the architect and architectural draughtsman took eighteen months to complete the ground survey of the city-mound,—although local handicaps had prolonged their work. Shortly after they had produced their finished map of the site, vertical air photos were taken.<sup>2</sup> The amount of extra detail recorded, and the increased accuracy which could be added to the ground survey, came as a surprise and a shock. It was agreed that none of the contours, as drawn, had put on record the faint depressions that were revealed by the air photographs as the main thoroughfares of the city.

Chastened but encouraged the expedition profited from this experience. It was agreed that considerable funds could have been saved here, and at Rayy; the expensive preliminary ground surveys were abandoned, and all subsequent excavation projects were based on aerial photographs. Schmidt describes in detail (*op. cit.*, p. 13) the way in which he laid down a survey grid of squares of  $100 \times 100$  and  $10 \times 10$  metres, by combining base points on the ground (marked by cloth circles 2 metres in diameter with black centre) and vertical air photography. The units of  $10 \times 10$  metres formed his standard excavation plots.

It is naturally in Asia, with vast sites on maps that are often inadequate, and arduous terrain, now desert, now jungle, that aerial survey aids ground survey most. Poidebard has described the Roussilhe method<sup>3</sup> which he used extensively and with great effect and speed, to plan large sites in mid-desert; the funda-

<sup>1</sup> Contrast, for example, the two excellent photographs in *Antiquity*, I, p. 272:—Pl. III, strip-lynchets near Worth Matravers, Purbeck (shadows towards the viewer); and Pl. II, 'Celtic' fields on Windover Down, Sussex (shadows away from the viewer, and relief turned 'inside out').

<sup>2</sup> Map and photos are printed for comparison, *Flights over Ancient Cities of Iran*, pls. 8-10.

<sup>3</sup> Cp. *La trace de Rome dans le désert de Syrie*, 1934, i, 12-14. Many of the earthworks which he found were impossible to survey on the ground only, being too ill-defined. It should be noted that the accuracy and usefulness of photographic scales which are calculated from flying height and focal length are much greater than he suggests; see p. 143 above.

mentals of this method will be explained in the next paragraph, and are applicable in most kinds of terrain. 'Nous avons là', Poidebard concluded, 'un procédé excessivement pratique et simple pour les relevés de reconnaissances.' For such ground-control and to collect surface finds of pottery, Schmidt, in Persia, frequently landed his aircraft on some adjacent spot that was conveniently level, immediately after taking his air view,—knowing that it was improbable that he would be able to return later on foot to all such remote places. At Oc-Eo,<sup>1</sup>

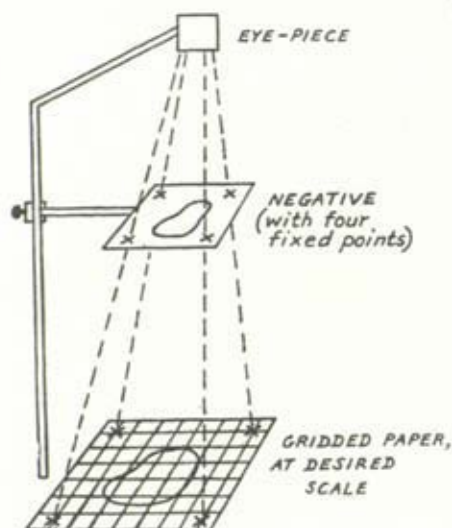


FIG. 4 A method of transferring details from a vertical air photo to a map, at any scale desired. See p. 64.

near the mouth of the Mekong in Indo-China, the whole site occupied by this ancient trading city (3,000 × 1,500 metres),—which has yielded Roman coins of the 2nd century A.D.,—was quickly planned from air photographs combined with ground control, by Prof. Mallaret in 1946. Equally in India and Pakistan the scope for such methods is clear. In British India the tradition of air archaeology goes back many years, but relatively few photographs have been published,<sup>2</sup> though many more have been taken. The full application of the technique for record and discovery, with far-reaching implications for archaeology on a sub-continental scale, awaits the future.

The procedure with the Roussilhe and similar methods is as follows (Fig. 4). First, four fixed points (e.g. rocks, corners of buildings, etc.) are picked out on the site, and the distances between them measured. The same points are then identified on the negative. This negative is placed in a horizontal glass screen or holder attached to an upright, and can be moved up or down. Next, beneath it on the table is placed a piece of paper with a grid of lines drawn on it at the scale desired for the survey (say 1 : 5,000). On the paper, the positions of the four fixed points are marked, in accordance with the measurements already made on the ground. The archaeologist then looks through an eye-piece with a small aperture, above both negative and paper, and the negative is moved up or down until the two sets of fixed points are seen to coincide. Still with his eye to the aperture, he traces on the paper the outlines of all the other topographical features that are to be recorded, thus producing a detailed survey at the scale decided. Needless to say, this technique is best for level terrain.

<sup>1</sup> In *Bull. École Française d'Extrême Orient*, 1944, XLV, fasc. 1 (publ. 1951), 75 seq.

<sup>2</sup> Some of the best can be found in *Ancient India*, No. 1, 1946, pl. XI (Tughlaqabad); No. 4, pl. I (Taxila II); No. 5, pl. XXVII (Sisupalgarh). Cp. Sir John Marshall, *Mohenjo-daro and the Indus Civilisation*, 1931, vol. i, pls. 1-II.



The foregoing method may well seem archaic and rudimentary to those who are engaged in air survey today,—but it has at least the merit of simplicity. Archaeologists should not be deterred, however, by the more modern apparatus,—much of it no more complex than other technical aids that have won their acceptance. Those who would see some of the newer developments should, for example, read the symposium on 'New developments in Photogrammetric Equipment, 1949-54', recently published in the U.S.A.<sup>1</sup> It covers progress by expert companies in Britain, Switzerland, France and Italy as well. The 'Multiscope', described by Professor Spurr (p. 698), is a type of instrument that archaeologists would find of great use. It meets the needs of the growing number of specialists (in geology, soil science, forestry and so forth) who regularly use vertical air photos in their everyday work, and who require accurate but cheap mapping from them quickly. The Multiscope combines (i) a mirror stereoscope, (ii) a camera lucida, (iii) a stereoscopic plotting transfer device. The scale of the photos can be enlarged or reduced up to three times when transferring their data to make maps. Instruments of this type have been made in several countries.

Such technical aids link the two rather distinct fields into which the use of air photos is divided normally: (i) photo interpretation, the estimation of what can be discerned from the visual image, and (ii) photogrammetry, precise measurement for mapping on a large scale. For the former, the simple pocket stereoscope (Plate 16) is effective enough for ordinary archaeological needs, but this is a toy by comparison with the many large and elaborate stereo plotting machines (e.g. the Wild 'Autograph') which have long been in use. It is a salutary experience for any archaeologist who is interested in mapping to see what the latter can do, particularly in mapping poorly-mapped regions from photo mosaics. It has been estimated that from 70 to 80 per cent. of the aerial photos now taken anywhere in the world are made into mosaics, either used as such or for the construction of line maps. Some of the processes used are more complex than archaeology requires, but not all (e.g. the rectification of tilt, aerotriangulation, the use of twin low-obliques, and so forth). Some of these have not been exploited in archaeology because their advantages have been so little known.

It must, besides, be remembered that it is not only with the spatial planning of topographical features in their relation to one another, but also with contouring and levelling, that carefully-taken verticals have a contribution to make to field-archaeology on suitable sites. Ground-air levelling is a commonplace of surveying practice, and should be taken into archaeological employment. Useful contoured plans of city mounds can be prepared in this way at a minimum of cost, but extra levelling (for further details) may be needed when excavation is about to begin. One simple method combines air photographs with selected

<sup>1</sup> *Photogrammetric Engineering*, vol. XX, September 1954, 621-711; a summary of developments from 1945 to 1949 was given in this journal in September 1949. I am grateful to Mr. Tristram Weatherhead of Hunting Aerosurveys for advice on these matters.

levels made in the field. First, several lines of levels are taken, crossing the site, and the record of these kept, as normally, in notebook and on sketch-map. Next, the points selected for levelling are marked out on the ground by prominent white crosses, visible from the air. Vertical air photos, with stereoscopic overlap, are then taken. A surveyor can afterwards sketch in the contours in a much shorter time than would be required to do them in the field, and with a satisfactory degree of accuracy.

It would, also, be possible to do a complete levelling direct from air photographs without setting foot on the earthwork, with the help of commercial companies who have the optical machines specially designed for such automatic work. It would be interesting to take a site with sufficient relief, and put this method to the test for its accuracy in terms of our requirements. But except for large and inaccessible 'tells', the archaeological applications of this particular technique are limited.

This is not the place for a full account of all the surveying skills of which the archaeologist can avail himself if he chooses, and which, if a little trouble is taken to understand them, will save him much expense and time for other things. Knowledge, as Sherlock Holmes (among others) remarked, is of two kinds: a relatively small body of facts which one needs to carry in mind, and the rest, which one knows where to look up. I am thinking, here, of the latter, and would refer field-archaeologists to a short list of clear and straightforward accounts from which to choose.<sup>1</sup> The elements of photogrammetry should be mentioned in all archaeological curricula, crowded though these may be. Finally, and to remove any possible misapprehensions, it will be appreciated that the methods described are not sufficiently accurate for the survey of excavated buildings, nor were ever intended to eliminate the need for ground survey but to increase its speed, comprehensiveness, and accuracy.

### THE PLAN VIEW

In this section I wish to compare some photographs of large, medium and small scales,—and to comment on points of interest revealed by shadow-relief on four famous sites from the Near East.<sup>2</sup> The details of the verticals are as follows:—

|               |     |     |             |            |                                 |
|---------------|-----|-----|-------------|------------|---------------------------------|
| Nimrud        | ... | ... | 6-inch lens | 2,250 feet | Scale <sup>3</sup> c. 1 : 4,500 |
| Tchoga Zambil | ... | ... | 6-inch lens | 4,000 feet | c. 1 : 8,000                    |
| Gordion       | ... | ... | not stated  |            | c. 1 : 10,000                   |
| Hatra         | ... | ... | 6-inch lens | 8,000 feet | c. 1 : 16,000                   |

<sup>1</sup> L. G. Trorey, *Aerial Mapping and Photogrammetry*, C.U.P., 1950; J. W. Bagley, *Aerophotography and Aero-surveying*, McGraw-Hill, 1941; A. J. Eardley, *Air Photographs: their Use and Interpretation*, 1942, 2nd ed., Harper, New York and London; D. L. Linton, *Geography and Air Photographs*, 1947, pamphlet publ. by the Geogr. Assoc., Manchester; *Manual of Photogrammetry*, publ. by the American Society of Photogrammetry.

<sup>2</sup> I wish to thank Aerofilms Ltd., a company of the Hunting Group, for permission to reproduce photographs of Nimrud, Tchoga Zambil and Hatra.

<sup>3</sup> The scales have been slightly reduced in the Plates.



Vertical photographs are pictorial maps and plans, but, as with printed maps, we need differing scales for differing uses. This is not of course intended to suggest that every site should be photographed at a variety of scales, but to affirm the need for attention to their separate uses. Such sites as those here illustrated cover a great deal of ground (although they can be matched by numerous others as big or bigger), and clearly another set of values would apply in the photography of Romano-British and Iron Age farmsteads and small individual sites, for which photos with scales as large as 1 : 3,000 would be the ultimate aim. This is an optimum figure: in fact in Apulia we took, and made full use of, verticals that ranged between 1 : 3,000 and 1 : 12,000, in order to deal appropriately with the thickly-scattered sites, Prehistoric, Roman and Medieval. The scales were suited to the purpose: small and medium scales are appropriate for search and mapping, and large scales for the promising sites. Ideally, this same principle is applicable to other suitable areas not yet explored by systematic air archaeology in Continental Europe (e.g. in France), whose potentialities are a main theme of this book. In breaking fresh ground there should be no hesitation about the value of medium scales, which give suitably extensive coverage. Photography of this kind has improved greatly in recent years, and in this, as in other techniques which archaeology employs, progress is going on all the time and must be utilised.

In Apulia we had the great advantages that come from military aircraft equipped for photographic reconnaissance, but it is not unknown for government authorities or private companies to give such facilities if the probabilities of discovery are clearly shown. I have elsewhere referred (pp. 114 and 144) to the admirable initiative now being taken in Italy by the Lerici Foundation, with the support of government organisations. But to put such facilities to full use it is essential to be clear about what can be got from photographs at various scales, be it in the setting of Europe, Africa or the Near East.

The photographs in this section illustrate the plan view of certain types of site and structure not shown by others in this book.

The acropolis of *Nimrud*, the Assyrian city named Kalḥu (Calah),<sup>1</sup> represents a type of site where ground survey can be aided from the air. The vertical on Plate 19 is one of a series taken in 1948 by a survey pilot, independent of archaeology. This excellent view has the merits associated with a large scale. The multitudinous scars of earlier digging and every particular of surface relief (including small bushes, clumps of weeds, and even grazing sheep) are well and truly to be seen. Through the stereoscope the site appears as a model in three dimensions. And with ground-control, as described on p. 63, such a photograph gives a welcome basis for planning, both in the sense of excavation policy and of survey.

<sup>1</sup> Twenty miles S.E. of Nineveh, Nimrud was made famous by Layard's excavations a century ago. The notable excavations directed by Prof. M. E. L. Mallowan began in 1949 and still continue; see reports in *Iraq*, vol. XII, 1950, 147; XIII, 1; XIV, 1; XV, 1; XVI, 1954, 59 and 115.



A point to note, in this case, is that it does not necessarily follow that a large photographic scale will inevitably produce discoveries, even on sites which are replete with buried structures. The surface of Nimrud's acropolis has been so churned-up in the past that even the positions of several palaces, disclosed by excavation, give no traces of their presence when the air view is studied.

But outside the acropolis,—clear of the disturbance of early digging,—one important structural feature can be clearly shown from the air. This is the buried quay-wall along the west side, or more truly the line of its position, along the foot of the slope which indicates the eroded remains of the mud-brick rampart (45 feet thick). In the golden days<sup>1</sup> when the city was a power in the land (up to the fall of Assyria in 612 B.C.), the River Tigris swept along its walls on this side,—but less than two centuries later its course had changed. Since then it has shifted several times, until now it flows more than a mile distant.

The existence of this very important quay wall<sup>2</sup> was first ascertained by a trench in 1952, and was reported in the *Illustrated London News* on 23 August. On re-examining the photograph on Plate 19 it appeared likely that the dark well-marked line at the foot of the slope might well indicate its course all the way down the west side, and in December I put this suggestion to Professor Mallowan, who was much interested in the possibility<sup>3</sup>. Confirmation came in the following year, when a second section was cut 40 metres further south along this line and exposed the quay wall again. There are indications on the ground that it was continuous not only along the western side of the acropolis but also round its S.W. corner to the south side; and Professor Mallowan reports that it even extended along the west side of the outer town, although in a simpler form.

Along the west side of Nimrud, the margin of conglomerate and sandstone beds gave a natural line which dictated the frontage of both the acropolis and the town. The quay wall diminished danger from river erosion, but its main function was as a continuous landing stage for river-traffic bringing treasure to the palace-ruler, and food, stores, and building stone for his city and army. In Assyrian times Nimrud was largely a military base; besides the acropolis there are 2 square miles of walled town, unexcavated until recently. It is reported that subsequent air photographs<sup>4</sup> have shown traces of buildings (? barracks) within the town proper. The beginning of the line of the mound which marks the town's wall can be seen on Plate 19, beyond the conical shadow thrown by the great Ziggurat<sup>5</sup> which stood at a corner of the acropolis.

The vertical view of *Tchoga Zembil* on Plate 20 is, I think, the first archaeo-

<sup>1</sup> The peak period was in the 9th century B.C. as a rich military capital of King Assur-nasir-pal II (883-59 B.C.). On the acropolis, remains of this period overlay those of an earlier city of Shalmaneser I (1280-60), and still more ancient pisé walls perhaps prehistoric.

<sup>2</sup> Consisting of very large blocks of limestone, the upper courses dressed and bonded, and water-proofed with bitumen:—height of stone courses up to 27 feet, width of quay up to 16 feet.

<sup>3</sup> Cp. *Iraq*, 1953, p. 39. For later work on the quay, *ibid.*, 1954, 65.

<sup>4</sup> Cp. obliques, *ibid.*, 1954, pl. X.

<sup>5</sup> For the history and religious significance of ziggurats see André Parrot, *Ziggurats et Tour de Babel*, 1949.



logical publication of an aerial plan of the site. This is a good example of a medium scale photograph (1 : 8,000); the whole of the extensive site,  $\frac{3}{4}$  mile across, is contained on one print, but the details remain clear. Every fold and twist in the gullies worn by erosion across the central enclosure can be seen, although they are only 1 to 2 metres deep. The site lies on the edge of a low plateau, grass-covered after autumn rains. North of the plateau, the ground falls in a series of eroded ravines (which from the air resemble crumpled paper), to reach the plain and its irrigable land along the river Ab-é-Diz.

This was a city founded in the 13th century B.C. by the Elamite king Untash Gal, 18½ miles S.E. of his better known capital at Susa. Assurbanipal the Assyrian king is thought to have been responsible for its destruction, about the year 640 B.C. It was not until 1935, however, that it became known to archaeology,—discovered by British geologists prospecting for the Anglo-Iranian oil company. They informed the French excavators at Susa, who conducted short seasons of digging at Tchoga-Zambil between 1936 and 1939<sup>1</sup>; and their trenches are visible on Plate 20, from a photo taken in 1948. In the last few years work has begun again, under Dr. Ghirshman's<sup>2</sup> direction. Shadow-relief outlines the earthworks containing the walls, which formed an inner and an outer enceinte. The larger enclosure measures c. 1,340 × 900 yards maximum and the inner c. 525 × 480 yards maximum.

At the centre of the latter rises a massive cone-shaped mound whose long shadow conveys some idea of its great height. From this mound has been disinterred a fine *ziggurat*, built of a huge mass of bricks. It had the usual stepped construction and parts of the five lower tiers from which it rose still survive to a total height of about 170 feet, forming what was in effect an artificial sacred mountain. Round its foot were grouped temple buildings, but it is noteworthy that on this site few traces of building-mounds are identifiable on the surface. Grass-markings visible between the western angles of the inner and outer enclosure do, however, suggest the possible existence of a large square enclosure, and excavation should test this corner. Little is yet known about the buildings in the outer enclosure.

It is through the kindness of Professor Rodney Young that I am able to publish Plates 21, 22 and 23 from Gordion in Turkey<sup>3</sup>, a group of air photographs of much interest, not only for what they show, but also for the

<sup>1</sup> Described in *Mémoires de la Mission Archéologique en Iran*, XXXIII, 1953, by R. de Mecquenem and J. Michalon, 'Recherches à Tchoga Zambil'. Although their site plan had been carefully surveyed, a comparison with this air photograph will show how much the latter adds in mapping such landmarks as the gullies. Ghirshman states that the base of the *ziggurat* is the biggest in Mesopotamia, *C. R. de l'Acad. des Inscr. et B.-Lettres*, 1954, 234.

<sup>2</sup> Cp. his accounts in the *Illustrated London News*, 6 December 1952; 8 August 1953; 3 July 1954.

<sup>3</sup> Acknowledgements and thanks are due to the Turkish authorities, to the University Museum, Philadelphia, and also to Mr. Seton Lloyd for information. The site lies 70 miles S.W. of Ankara and fulfils the topographical requirements for identification with the city of Gordion described by classical writers,—a capital of the dynasty of King Midas and the scene of Alexander's visit in 333 B.C., associated with the episode of the cutting of the Gordian knot.



possibilities they indicate. The verticals are good examples of medium-scale views, being c. 1 : 10,000. I have already stressed the vital part which aerial mapping has yet to play in the archaeology of Anatolia<sup>1</sup>. It is a matter of such importance, for all periods, from prehistoric to medieval, that I am very glad to have these useful illustrations to emphasise the point.

It will be readily appreciated, as the oblique view on Plate 21 makes very clear, that this and like parts of Anatolia are ideal terrain for air archaeology and particularly for crop and grass mark sites. One is not exaggerating in describing the potentialities as tremendous. Such terrain is even more suitable than Apulia's has proved, and for much the same reasons:—prairie lands without a hedge in sight, baked with sun, and carrying an abundance of grass and corn.

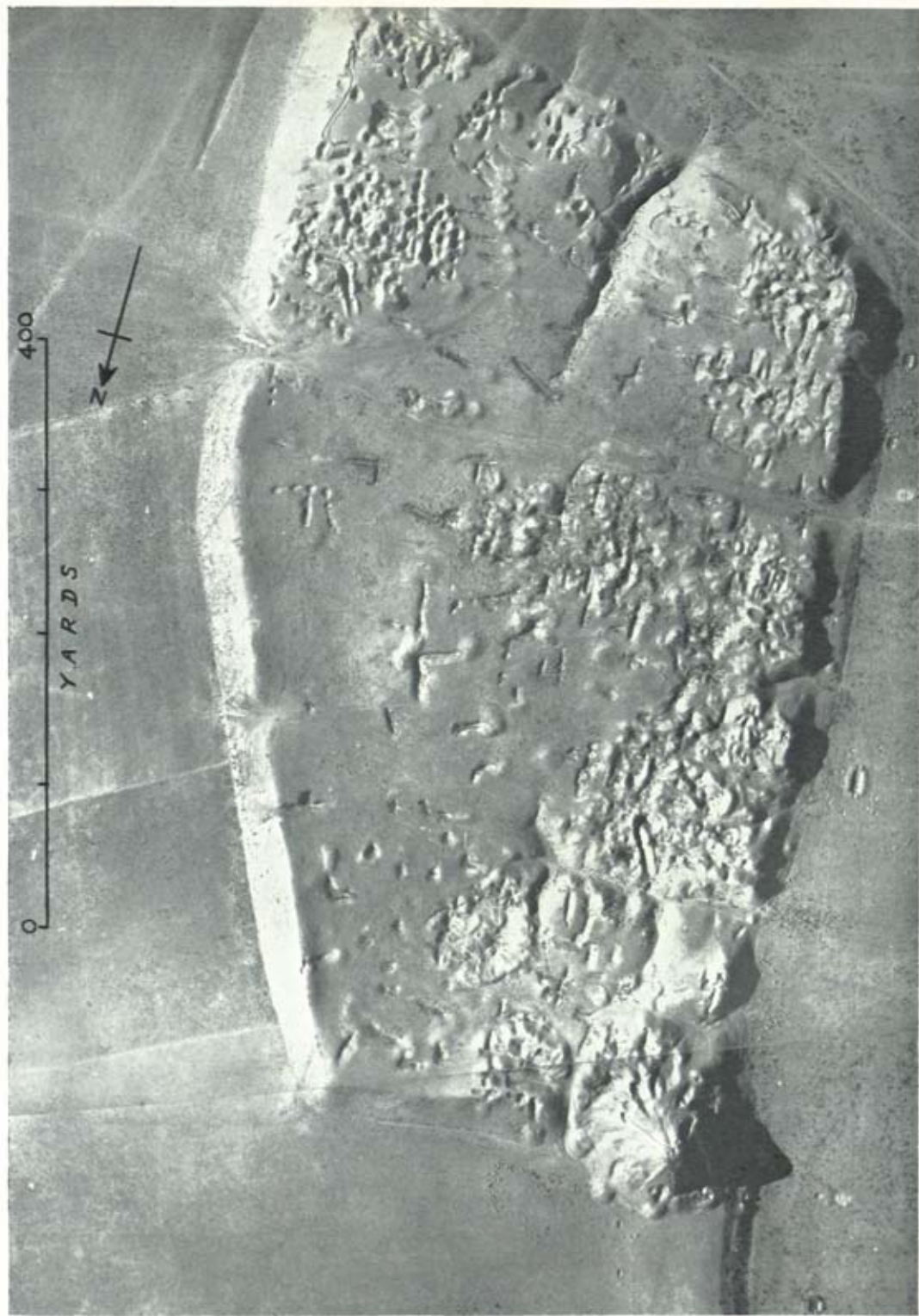
The city mound of Gordion, a flat-topped 'tell' measuring 400 yards across the top, has been excavated for the University Museum of Pennsylvania by Professor Young during recent years, and much has been learnt of its history.<sup>2</sup> Setting aside small Islamic and Roman hamlets, the upper levels were notable for the remains of a flourishing Hellenistic town, deserted at the end of the 3rd century B.C. Below this lay another town with a wall 25 feet thick, whose original construction appears to date from the mid-6th century, and under this have appeared buildings of a town of the Phrygians several centuries older still. Hittite and Early Bronze Age pottery from lower levels extends the history of the site back to some time in the 3rd millenium B.C. At a depth of 50 feet water level was reached. To the south-east, seen on the right-hand margin of Plate 21, is a separate mound, a subsidiary part of the city. It would appear that the Sangarios river may have flowed between this mound and the main city originally, and has changed its course since.

This is the archaeological background, in briefest outline, to the highly important burial mounds whose remains are seen scattered over the surrounding flood-plain (Plates 22 and 23). The largest group lies east of the Sangarios river that flows past the city and near to the village of Yassihuyuk and a huge conical mound (seen in the background on Plate 21 and near the centre of Plate 22). From the top of this mound (proved to be an out-size tumulus) 80 or more tumuli, large and small, can be counted. A number have been completely excavated, and dated by imported objects (e.g. Greek pottery) to the 6th and 7th centuries B.C.; Plate 22 illustrates the aerial aspect of tumuli in this group, during excavation. Their stony mounds are made clear by a combination of soil-markings and reflected light. Many, of course, are obvious enough on the ground (one of those already excavated being 160 feet across and another

<sup>1</sup> One has only to think of the assistance it would give to the regional surveys of earthworks by ground reconnaissance, which have already made very considerable progress: see Seton Lloyd, *Antiquity*, 1954, 214-20, 'Mound Surveys'. Air reconnaissance based on a combination of visual observation with 35 mm. Leica photography for record purposes might form a preliminary step.

<sup>2</sup> *Anatolian Studies*, vol. I, 1951, p. 11; II, 20; IV, 16; VI, 17. For the drilling into burial mounds, *Illustrated London News*, 10 Nov. 1956.





19. IRAQ, NIMRUD. Vertical view of the Assyrian citadel. Originally the river-bed of the Tigris ran along its western and southern sides. Along the west side, at the foot of the rampart, shadow-relief shows the position occupied by a buried riverside quay. The ziggurat, and the continuation of the perimeter of the city, can be seen in the lower left corner. The surface of the citadel is scarred by old excavations. The 'total mapping' of such large sites requires aerial survey. See p. 66. *Ph. Aerofilms Ltd.*



20. SOUTH-WEST PERSIA, TCHOGA ZEMBIL. A vertical photo giving a plan view of the site of the city and its environs. It was founded in the 13th century B.C. At the centre is the ziggurat, enclosed by inner and outer walls. The trenches of recent excavations can be seen. Surface markings suggest the presence of a complex of buried buildings inside the western angle of the outer rampart. Aerial survey is most valuable in mapping such large sites. See p. 69. *Ph. Aerofilms Ltd.* 1948.





21. WESTERN ANATOLIA, GORDION. Oblique view from the south-west to show (centre) the flat-topped city-mound in its setting, with the 1951 excavations in progress. On the left, the present course of the Sangarios river; on the right a part of another mound, subsidiary to the city; in the background, a huge conical mound and the zone of tumuli shown on Plate 22. See p. 70. *Ph. by courtesy of the University Museum, Philadelphia.*



22. GORDION. Vertical photo showing part of the zone of burial mounds beyond the village of Yassihüyük. They range in size from the huge mound (A) to smaller mounds (e.g. B). Some have been partly levelled (e.g. C). The circular light-toned soil-marks, which the aerial view makes clear, help in mapping the outlines of such tumulus mounds. See p. 70. *Ph. by courtesy of the Turkish Air Force and the University Museum of Philadelphia.*



22 feet high),—but others, especially the smaller ones, have been much worn down by weathering and by cultivation. The aerial view makes it much easier to see their outline and to map all such traces throughout a large area. Some care is necessary, however, to eliminate the whitish surface markings, caused by the subsoil breaking through into the top-soil as the result of ploughing and weathering. In addition to the tumuli, many humbler graves have been found, of almost all periods, and the area was apparently always regarded as a cemetery for the inhabitants throughout the long history of the town. A scatter of tumuli can also be seen on the opposite (west) side of the river, towards the village of Kiral Harman. Some of these can be seen on Plate 23, on arable ground, and although they have been much ploughed-down their outlines are clear. The faint parallel lines from east to west are caused by modern cultivation, and the darker tone in the S.E. corner is due to damper ground towards the river. Summing up, excavation has shown (from the wealth of gold and electrum jewellery found) that such massive burial mounds were for rich and prosperous families; the constructional methods are specially interesting too, with wooden burial chambers roofed and walled with planks or logs for the 7th century Phrygians. This type of burial was later replaced by elaborate cremation rites.

It is to the diagnostic value of air photographs in recording or revealing the location of such tumuli in Anatolia that I should like to draw particular attention here. These photos had an overlap for stereoscopy, and low tumulus mounds 'stood up' very well when examined in this way in order to gauge their relief.

A stage is often reached when synthesis is needed more than detail, and then it becomes useful to have the synoptic view of a whole city and its environs, or of some extensive field-system, spread out on one or two prints only. Thus, vertical photos of *small* scales have many uses in those parts of the world in which archaeological mapping has still much to do. Two or three prints with a scale of 1 : 16,000 were enough to cover a site as big as Hatra<sup>1</sup> (Plate 24), plus its outer girdle of siege-works, and also to give stereoscopic examination of the whole complex so that with the mind's eye one can walk at will among the mounds and picture the ground view. The vast skeleton of the town lies isolated on the bare steppe-desert. My study of these air photos also showed signs of markings east of the city which may be part of the siege-works, but they await confirmation by ground-checks.

Hatra was a city state ruled by its own kings, within the Parthian Empire. It resembles the type of bustling 'caravan city' in the sense of Rostovtseff's<sup>2</sup> familiar term. From these air photographs one can trace the course of a dozen ancient

<sup>1</sup> Ninety-three miles south-west of Mosul in northern Iraq.

<sup>2</sup> Cp. Sir Aurel Stein, *J. Royal Asiatic Soc.*, 1941, 299 seq., 'The Ancient Trade Routes past Hatra and its Roman Posts'. In 1938-9 he carried out aerial reconnaissance round Hatra with the help of the R.A.F., spending more than two months in the examination of this part of Rome's Mesopotamian defences. 'The large series of air photographs secured were of great help in the field', see *J.R.A.S.*, 1938, 423-6, and *Geogr. Journ.*, 1940, Jan.-June, 428-38. Some of his findings are being revised by a current ground-check.



routes that radiated outwards like the spokes of a wheel. The origin of the town is still obscure but its foundation is believed to date from either the last century B.C. or the first A.D. Hatra was a typical hybrid between the Mediterranean world and Hither Asia, showing Hellenistic influence in some of its chief buildings but having the lines and lanes of an Asiatic town. It stands between the Tigris and Euphrates in a marginal 'forward zone' of Roman frontier policy, and makes a dramatic appearance in western history in the reign of Trajan when he attacked it unsuccessfully in 117 A.D. In the end the besiegers besieged themselves with hunger and thirst. The neighbourhood gives grazing for camels in winter and spring, and wells sufficient for them, but not enough water for an army, especially one that was largely European.

Severus made two further attempts in 198-99 to capture the town,—a desperate affair on both sides.<sup>1</sup> About thirty years later the Parthian empire was overthrown by Ardashir, founder of the Sassanian dynasty; and it was his son Shapur I who eventually captured and sacked Hatra about the time that he destroyed the 'caravan city' of Dura-Europos (245 A.D.). The soldier-historian Ammianus Marcellinus took part in the Emperor Jovian's retreat past Hatra in 364 when the city was desolate; yet this age-old desert route had evidently survived. In the Middle Ages there was a flicker of caravanserai life among the ruins, which were eventually rediscovered by Ross in 1836 and described by Rawlinson.

The standard account and plans are still those produced by the German field-survey mission more than forty years ago,<sup>2</sup> while a reconnaissance by O. G. S. Crawford in 1929 demonstrated the potentialities of air photography.<sup>3</sup> But it was not until the spring of 1951 that sustained excavations were begun, by the Directorate General of Antiquities in Iraq.<sup>4</sup> These continued for four seasons, and ten temples and the north gate were examined. The discoveries, especially the sculpture and the inscriptions (almost all in Aramaic), were of the greatest interest. There existed a notable mixture of Graeco-Roman and indigenous culture. Its inhabitants, apparently of Arab stock, were eclectic in religion: what mattered to them was the efficacy of a god or his attributes. Shamash the sun god was the chief of many deities, but images of Hercules

<sup>1</sup> Trajan and Severus nearly perished with their forces, owing to the vigorous defence and to lack of water and grass in the desert which made a big army vulnerable. Cp. Dio Cassius, book 68, 31; 75, 11; Herodian, book 3, ch. 9, 3-7; Ammianus Marcellinus, XXV, 8, 5. See F. A. Lepper, *Trajan's Parthian War*, 1948.

<sup>2</sup> W. Andrae, *Hatra*, pt. i, 1908, pt. ii, 1912. This expedition concentrated on field survey and not on excavation.

<sup>3</sup> *Geog. Journ.*, January-June 1929, 501-2, with vertical view of the great Palace-Temple quadrangle at the centre. This symmetrical enclosure for the ruler contrasts with the layout of the ordinary streets,—some of these are fairly straight but regular planning was not applied to them. The city's wall (which is double) is not a perfect circle but consists of straight sections joined: its circumference is about 4 miles, with c. 160 towers and 4 main gates.

<sup>4</sup> Cp. brief summaries by Dr. Naji al Asil in the *Illustrated London News*, 10 and 17 November 1951, and 18 and 25 December 1954, and by Fuad Safar in *Sumar*, 1952, pp. 3-16 (results of first season), 1953, p. 7 seq. (inscriptions), 1954, 84. D. Oates, *ibid.*, 1955, 39 on Roman forces in Hatra by 235 A.D.



were very popular by the 3rd century A.D. One notes, too, that the statue of Princess Washfari, daughter of Senatruq one of Hatra's greatest kings, is curiously Indian in feeling. The Hatra sculptures show a most interesting blend of Hellenistic, Parthian and Semitic elements.<sup>1</sup>

So much by the way of thumb-nail introduction: what has Plate 24 to contribute? It gives a pictorial plan of the entire city and its environs. The jumbled mounds of buried house-walls take on coherent outlines;—built round open courtyards as they were, this gives a honeycomb appearance. True, the photographs' scale (1 : 16,000) was rather small for book illustration, but quite adequate for mapping the main features of the street-plan. The ideal photographic scale for the topographical study of such cities is about 1 : 6,000. A good series of large-scale verticals was taken in 1936 over Hatra and again in 1938, and these I have examined with care.

One might think that there was little scope for improving on Professor Andrae's detailed volumes, but air photos reveal many house blocks, and even complete streets, which can now be added. This is most apparent in the north and south districts, and round the lake in the south-west quarter. The result is the filling of large areas left blank on Andrae's town-plan, printed at the end of his second volume. Some corrections, too, are necessary to the alignments of certain streets which he mapped.<sup>2</sup> The photos also confirm the suburbs outside the east and west gates, previously in some doubt. On the west, the siege-wall makes a corresponding détour.

All these additions and improvements have now made the preparation of a new and comprehensive plan of the town very desirable. For this the various air photographs that already exist could supply a good basis, but certain details would naturally require a ground-check on the spot. So far, the 1951-54 excavations have not included any newly surveyed plan of the town as a whole, but the situation is opportune for combined ground-air mapping.

There is another matter with which Plate 24 also helps. I refer to the circular line of circumvallation, a low earthwork only a few feet high, that forms a continuous girdle tightly drawn round the city about 450 yards from its walls. The nature of this siege-work, carefully built of stone and soil, was described by Andrae (ii, 20-23). Air photos fill the gap in its course on his map and amend the line he gave it east of Hatra. At this point, the breastwork swung away from the city in a series of unusual zig-zag salients. Close up against its outer face can be seen a substantial flat-topped mound (Plate 24, at A), very probably connected with the circumvallation. Andrae labelled it '? Kastel'.

<sup>1</sup> Cp. H. Ingholt, 'Parthian Sculptures from Hatra', *Memoirs of the Connecticut Academy of Arts and Sciences*, vol. XII, July 1954. Recent excavations have found two magnificent and dignified statues of kings of Hatra in Parthian dress (wearing trousers).

<sup>2</sup> But, considering the great difficulty of surveying innumerable irregular house-mounds at eye-level, Andrae was notably successful. His photos (ii, pls. 5, 9, 32) of the 'sea' of mounds inside the city should be compared with the air view. For a description of a modern method of air survey supported by ground-control, for dealing with large city sites, see p. 63 above.



It is rectangular in outline, about  $50 \times 30$  yards, perhaps a platform for *ballistae*. There is some resemblance to the massive artificial mound adjoining Camp G in the Roman siege-lines round Masada, in Judaea above the Dead Sea; that mound stood about 350 yards from Masada's walls, and has been interpreted as a probable position for *ballistaria* emplacements.<sup>1</sup> Dio, it may be noted, also tells us that Severus watched the progress of his siege of Hatra from a raised vantage-point. Counter-battery fire was exchanged by the siege engines on both sides, and those of the Roman forces were burnt in the first attack. The defenders used bituminous naphtha, and a unique form of hand-grenade consisting of pots filled with 'little venomous winged creatures' which severely troubled the attackers! Finally, the Roman troops mutinied.

Andrae considered that the circumvallation might be attributable to Shapur, but in 1929 Crawford reasonably claimed a Roman origin for it. In 1941 Sir Aurel Stein commented that the size of its circumference, over 5 miles round, indicated a prolonged siege,<sup>2</sup> and he thought that a Sassanian origin seemed justified. This is an important question that needs to be investigated further by excavation. It is a unique opportunity, for desert conditions preserve such field-fortifications better than any other terrain. Very important questions are posed by the long straight lines of soil-marks (apparently related to the circumvallation) which are revealed by this air photo (Pl. 24,C).

It is noteworthy that the air photographs show no traces of ancient field systems in the neighbourhood of the city. Several writers have doubted whether irrigated cultivation was practicable here. But the recent excavators have stated that the surrounding semi-desert can be fertile if properly worked, and in years of rain will give a good harvest.<sup>3</sup> All things considered, however, the reasons for founding a city at this point are not obvious, topographically. In the deep Wadi Tharthar, 2 miles distant, water flows only after heavy rains. Nomads who pitch their tents at Hatra contrive to make do with 'natural wells', fissures in the limestone with about 6 feet of brackish water:<sup>4</sup> and it is possible that ancient

<sup>1</sup> Cp. C. F. C. Hawkes, *Antiquity*, June 1929 (correlating air photos with other sources). Schulten's monumental reports on the chain of Roman works round Numantia in North Spain (text, 4 vols.; plans, 3 vols.; 1914-31) contained only one air photo, taken in 1918 (vol. ii, pl. 11). But the remains and bare terrain are ideally suited to air mapping (compare vol. iii, taf. 2-3), and a vertical survey could make additions even to this thorough record. In Scotland, a probable instance of Roman siege-lines in front of a tribal hill-fort has been recorded from the air by J. K. St. Joseph, at Woden Law in Roxburghshire. It has been suggested that they were built during field-training and not for operations, *R.C.A.M., Roxburgh*, 1956, i, 169 and pl. 31.

<sup>2</sup> Against this, it is important to note that large earthworks can be raised very quickly by men under pressure, as all wars prove.

<sup>3</sup> I am grateful to Mr. Safar for the opportunity of discussing this important question with him in 1955; he now feels doubts about the possibility of regular cultivation. Crops grew in the first experimental year (1951) when it rained, but in the three following years the rains did not come. Hatra lies on the edge of the zone where rain falls today. If there had been centuries of ancient agriculture, surely property-boundaries would be visible! But they have not been found. How was the city fed, if not by caravan trade? The radiating tracks, shown by vegetation marks, are suggestive of this.

<sup>4</sup> Today, all the water at Hatra is said to be brackish. But in the city almost every house had a deep well and there was a permanent lake.



pastoralists foregathered at some earlier village at this spot. For the present, Fuad Safar concludes that the main factor in the foundation of Hatra as a city was probably a military one. But its importance in caravan trade and as a religious centre must have been essential to its prosperity. Even today the Baghdad to Mosul caravans take their route past the site, availing themselves of the springs.

### SCOPE AND LIMITATIONS OF SEARCH

Like light and shade these are complementary aspects, and here will be treated together. One point, rightly stressed by other writers, is that it is the clues from field-work on the ground which often lead the way to discovery from the air, as well as *vice versa*. Even in regions of proven suitability for air archaeology, the terrain imposes definable limitations on discovery. Moreover the method is often powerless to reveal certain kinds of buried site, as for example many types of individual grave, post-holes of small timber houses, and a great variety of others;<sup>1</sup> and is unlikely to add much to the knowledge of some types of earthwork visible above ground. Furthermore there are substantial areas in which conditions of terrain<sup>2</sup> or modern cultivation militate decisively against it. In short, like many specialised techniques the range of its powers is selective, and so must be its uses. As regards Britain the works already cited in the opening pages give a clear picture of policy, and therefore in this section we shall look further afield. That the facts are few and far between should be a challenge, and brief reference to select topics is in fact all that is possible at the time of writing.

Let us begin with France. I have examined many of its regions with the aim of assessing their potentialities for aerial discovery; some are favourable, some are certainly not. In the latter category must be placed the vine-monopolised areas that fill the Rhône valley and the Bordeaux region. Favourable areas are, notably, the Pas de Calais and Normandy (with parts of Brittany) where the fields are big, with plenty of corn and grass. Some years ago I made a special study of photographs of the Somme valley, hoping that its chalk and gravel subsoils would furnish crop-sites like those in the upper Thames valley. They did so. North of Amiens, towards Villers Bocage, a dozen or more circular ring-ditches in crop-mark form were found,—evidence of ploughed-down tumuli, completely levelled. Near the mouth of the Somme, the photographs showed a number of others between St. Valéry and Abbeville, on chalk ridges along both the north and the south bank. They were especially clear on rising ground between Noyelles and Port le Grand, a siting which can be conveniently

<sup>1</sup> In special circumstances, however, an unusual degree of detail is visible. One instance is the regular pattern of small dark-toned dots arranged in squares or oblongs in the Roman camp at Glenlochar in Scotland. These crop-markings may indicate the sites of lines of skin tents: *J.R.S.*, 1951, 60 and pl. VI, 2.

<sup>2</sup> But even in Switzerland, with limited areas of suitable terrain, successful reconnaissances have been made: cp. H. G. Bandi, *Ur-Schweiz*, IX, 3, 1945, 49-58.



seen by the traveller on the main railway line from Paris to Calais, which passes through these places. Since then I have found examples from areas adjacent. These markings were discovered from photos of 1 : 10,000 scale, when studied through an ordinary stereoscope magnifying two or three times. The diameter of the circles ranged from 70 to 100 feet. In brief, it has been established that north west France is full of crop-sites.<sup>1</sup> Further details of these observations will be published in due course; one of their consequences has been to show how the areas suitable and unsuitable for search can be differentiated.

Brief reference has been made (p. 7) to the remains of Iron Age field-systems in Denmark as a very promising subject for air archaeology, which, it seems, has not as yet been systematically applied. Considerable traces of the low banks which enclosed these corn-plots have already been mapped on foot on the moors of Jutland.<sup>2</sup> Often, however, the slight relief of the banks is made difficult to see at eye-level by the covering of heather. If photographed as shadow sites, with low obliques taken against the sun, much would be added. Further I can vouch for the fact that, even where levelled by modern cultivation, their outlines survive very clearly as crop sites and soil markings (as with our own 'Celtic' fields), and that by making full use of these buried landscapes large additions can be mapped from vertical views. This conclusion is based on a ground-check which I carried out in 1954.

Turning to another practical problem: there are hopes that in the neighbourhood of former Roman *coloniae* in Spain, or even in Portugal, aerial mapping might elicit traces of the Roman division of the landscape by a grid of roads (*limitatio*).<sup>3</sup> My preliminary study of maps of 1 : 50,000 scale (the best available) has not yet produced satisfactorily convincing remains; but this is by no means conclusive. The pre-war 1 : 50,000 maps of Dalmatia, for example, marked few of the minor roads round Zara and Salona, which in fact preserve the

<sup>1</sup> Cp. also *Antiquity*, 1953, 242 and pl. VIII, an oblique of a triple concentric circle as a crop-site, near Villenaux-la-Petite (Seine-et-Marne) not far south-east of Paris.

Forecasts of discoveries, given above, have been confirmed by the crop-marks of a site of Neolithic type found by Mr. Scollar at Spiennes, Belgium; *Antiquity*, 1955, 159 and pl. 1. But what systematic efforts have been made to locate from the air the levelled Celtic tumuli of the 4th-6th cents. B.C. in Belgium, East France, or South Germany? The famous Vix tumulus was no more than 'une très légère éminence' like many found in Etruria (Chapter III), only 25 cms. high and 'pratiquement invisible pour un oeil non prévenu'; R. Joffroy, *Le Trésor de Vix, Côte d'Or*, 1954, and *C.R. de l'Acad. des Inscri. et B.-Lettres*, 1953, 27 and 170. Air survey might locate more than one site equal to Vix.

<sup>2</sup> See Gudmund Hatt, *Oldtidsagre*, Copenhagen, 1949. Such fields continued in use in the Roman Iron Age. Cp. similar remains in Holland: blocks of small rectangular 'Celtic fields' found by ground observation on heath lands north of Zeyen in Drenthe province (van Giffen, *Antiquity*, 1928, 85 and map, and in works cited by Crawford, *Archaeology in the Field*, 1953, 275).

<sup>3</sup> One Roman surveyor (Hyginus Gromaticus) explicitly mentions the existence of *limitatio* at *Emerita* (Merida) and even the size of the units, 40 × 20 *actus*. A straight country road, marked as 'Calzada Romana', which runs N.N.E. from the town for 3½ miles should, presumably, give the key to the orientation of the system. The area round Beja (*Pax Julia*) in south Portugal has been suggested as a possibility.

Air photography would no doubt reveal many Roman camps, e.g. in the Guadalquivir Valley; cp. H. H. Scullard, 'A note on the battle of Ilipa', *J.R.S.*, 1936, 19, with suggested camps of the Roman and Carthaginian armies in this vital contest for the mastery of Spain c. 206 B.C.



Roman grids now demonstrable (Chapter IV). It is reasonable to suggest that air photography in Spain might add the same necessary amount of accurate topographical details, or reveal traces of buried roads also. Ordinary medium and small scale prints, as used for map revision, would be sufficient to settle the matter; it is hoped, at least, that the maps so revised will become available. It seems probable, however, that any remains of *limitatio* that are still preserved by boundaries above ground must prove to be of a very fragmentary kind, comparable to those slight vestiges just perceptible in southern France at Valence which air photos enabled me to identify and to map (Fig. 20). Round most Hispanic towns the existing roads and tracks radiate out in all directions as in southern Italy, suited to peasant convenience. In such regions conditions in the Dark Ages and later evidently played havoc with neatly gridded systems when the countryside took refuge in the town.

As regards Italy, I may mention a few details. Aerial examination of the sites of several well-known prehistoric *terremare*,—settlements in the marshy Po valley,—has not shown me much that is of interest structurally, but in the form of terrain study (of ancient water-channels, for example), it may yet prove helpful. Tiny fields, irrigation, and such crops as maize, make the Po Valley unrewarding for most types of air-photo site. One line of investigation which I am following is focussed on the remains of ancient field-systems in the uplands of pre-alpine zones. But these, although interesting and neglected, are peripheral. The vitals are in the peninsula, and there is much well-trodden ground between Rome and Bologna that is going to produce a quantity of new aerial finds. I have further examples to publish from Etruria; one such find has been the system of buried roads radiating from the site of Vulci.<sup>1</sup> But in many areas from which discoveries would be welcome, as for example the coastline between the heel and toe of the peninsula, extensive olive cultivation is a very limiting factor. In Sicily, the coastal plains on the south (e.g. round Licata) and certain grassy uplands in the centre are the most hopeful regions, showing some traces of markings that resemble the Neolithic sites in Apulia. The corn and grass covered lowlands of south and west Sardinia also give proof of being a promising field for aerial discovery.

In Greece, air photographs were used for archaeological purposes as far back as 1916-18, by French forces on the Macedonian front.<sup>2</sup> Since then a selection of well-known sites have been photographed for Greek government departments, and prints from R.A.F. sorties of the last war have been examined in search of new sites. But the true need is, now, for a programme of systematic archaeological reconnaissances with careful planning beforehand, on similar lines to that now taking shape in Italy (p. 85 seq.). Professor Richmond's article on 'Recent dis-

<sup>1</sup> The lines of numerous roads can be traced round the site of this Etruscan and Roman town (and round others). Most of the roads have been buried by cultivation, and the traces of some which I have examined on the spot have been almost invisible at eye-level.

<sup>2</sup> For examples see Léon Rey, *Observations sur les premiers habitants de la Macédoine, recueillies par le Service Archéologique de l'Armée d'Orient, 1916-19 (Région de Salonique)*, 1921, Bocard, Paris.



coveries in Roman Britain from the air and in the field' (*J.R.S.*, 1943, 45), is a model of the kind of balance sheet of possibilities and potentialities that can be drawn up to guide policy, on the lines of a commander's 'appreciation' before action. It is not difficult to think of concrete problems to which this method could usefully be applied in Greece, or to eliminate the less suitable areas. Terrain and cultivation make the plains of Larissa in the north and Agrinion in the west ideally equipped to produce buried sites from crop markings. That crop sites and soil markings are worthy of greater attention has been illustrated by an instance from Attica (Plates 6 to 10) and this could be supported with other examples which are awaiting the complementary field work that is necessary.

Central Europe has long been associated with the extreme development of strip-field cultivation which sometimes reaches a *reductio ad absurdum* in the thinness and length of the units, and whole regions are thus parcelled out. This intensive cultivation tends, by attrition, to 'iron out' the remains of many sites. Further, the deep soils of the alluvial plains inevitably lessen the conditions which produce crop markings, and the variety of cultivation in the consecutive strips is also very much against them. The effect of such limiting factors is considerable but not, of course, total.

One of the finest subjects for air archaeology in Europe seems at present a remote possibility. The trans-European fortified frontier developed in stages under Roman rule from North Sea to Black Sea contained a great variety of defensive works and advanced positions, the whole bound together by military roads and sited in considerable depth. We have proofs, from the tentative beginnings made, of the enormous amount of information that could be added from air survey, by straightforward mapping in the less-studied sectors and by the location of buried sites in the better-known ones. A noteworthy use of air photography was made by A. Radnoti when mapping the remains of a Roman *limes* in north-east Hungary.<sup>1</sup> It is tantalising to think of those other linear earthworks marked as 'Roman' on pre-1914 Austro-Hungarian maps. These form major systems in north-east Yugoslavia (north of Novi Sad), and in western Rumania (through Temesvar and Arad from south to north),—to say nothing of linear earthworks on a great scale in Bulgaria.<sup>2</sup> It would be unwise to label all these Roman prematurely: the Dark Ages and Middle Ages may also have contributed to them. As a point of practical archaeological importance I should record here that the sites of levelled earthworks closely resembling square Roman forts or camps are distinctly traceable in the form of *buried* sites shown by crop-marks in the Mezobereny area in eastern Hungary, and on both sides of the Danube near Turnu Severin (the 'Iron Gates').

<sup>1</sup> Cp. 'Il *Limes* di Dacia sulla montagna Meszes', *Archaeologiai Ertesito*, Budapest, 1944-5, vol. V-VI, 151-68 and pls. LXIII-LXVIII:—ten vertical air photos of vallum, forts, observation posts, etc., in the neighbourhood of *Porolissum* in north-west Dacia. For other air photos of sites in Hungary, cp. L. Radnai in *Arch. Ertesito*, 1940, 65, pls. XIV-XVI.

<sup>2</sup> For further details, see O. G. S. Crawford, 'Some linear earthworks in the Danube Basin', *Geogr. Journ.*, December 1950, 218-20.





23. GORDION. Soil and vegetation marks indicate five levelled burial mounds in a zone which has been ploughed. The white marks on the edge of the village of Kiral Harman (right) are threshing floors. See p. 70. *Ph.* by courtesy of the Turkish Air Force and the University Museum of Philadelphia.



24. NORTH IRAQ, HATRA. A vertical plan-view of the site of the ancient city, which flourished in the first three centuries A.D. It shows the ramparts, house-mounds, streets, and central temple-palace enclosure; and adds many details to previous plans. The dark radiating lines indicate ancient caravan routes. (A) A large artificial mound, perhaps prepared for siege-engines. (B) A white stony line shows the traces of the surrounding siege-wall, and gives the first precise record of its complete course. (C) Long, straight, white soil-marks revealed from the air; their date and function are not yet certain. See p. 71. *Ph. Hunting Aerosurveys.*



It is symptomatic of the disordered world in which we live that a German air photograph of 1918 giving details of a Roman frontier wall in Rumania was only published for the first time in 1954, and in England.<sup>1</sup> Pictorially it is an important document, showing a part of the Roman *limes* with its forts 5 miles west of Constanza in the Dobrudja, and forms one of a series of vertical views that was taken. A little further north are the remains of a still more extensive system of ancient linear defence, running east-west from the Black Sea to the Sereth (Siret) river<sup>2</sup> at the foot of the Carpathians. This major piece of earth-work has been recently studied by Professor Vulpe, who considers it a 4th cent. Roman work (though the possible claims of the Byzantine Empire cannot for the present be entirely eliminated) but here again air survey is needed to map its details and complete the military picture. Many times in history this zone has been the gateway into southern Europe from the Asiatic land-mass for horse-riding forces. In our own times armies have attempted, vainly, to fasten a bolt-line across this gap between the Carpathians and the Black Sea over almost the selfsame ground that anciently had been chosen.<sup>3</sup> The topography gives the defence little alternative.

If we briefly direct our gaze into Africa and Asia, where life moves on a vaster scale, in regions remote to archaeological penetration, it is evident that one must be prepared to make increased use of the growing number of air surveys made for various administrative purposes. It is not only a matter of finding where the larger sites are, but also where they are *not*. True, flights planned specifically for archaeology are the ideal solution, but resources only allow of this in special cases. The dilemma is more apparent than real: half a loaf is better than none.

By December 1953 about 44 per cent. of the earth's land surface had been photographed from the air at least once; such is the conclusion of Professor K. H. Stone who has made a thorough study, recently published under the title 'World Air Photo Coverage, 1953'.<sup>4</sup> Too often, as he points out, specialists have not tried to obtain photographs because of uncertainty about prohibitions attending military security,—doubts which often are unjustified. To prove the point he publishes a map of the world air photo coverage which is available.<sup>5</sup> Many details are given of the type, scale, and so forth; this is of great value as a work of reference, which it would be pointless to re-summarise, and the reader is best referred to the original. Of course much of the coverage is of too small a scale to benefit archaeology much (1 : 25,000 and smaller, of trimetrogon

<sup>1</sup> Cp. O. G. S. Crawford in *Antiquity*, 1954, 208 and pl. VI, with reference to Schuchhardt's study of this *limes* published in 1918 before the photographs were taken. Further references to this and adjacent systems are listed in his *Archaeology in the Field*, 1953, 212.

<sup>2</sup> *Antiquity*, 1954, 224-6. It can be added that ditch-enclosed sites resembling that of Neolithic date excavated recently at Habașești (not far from Cucuteni and the Sereth) are visible from the air.

<sup>3</sup> For example, compare the part played by the 'Sereth Line', in 1944 (W. E. D. Allen and Paul Muratoff, *The Russian Campaigns of 1944-5*, 163). The collapse of this modern German *limes* brought a catastrophic defeat and opened the way into the Balkans. I studied the region in detail at this time.

<sup>4</sup> *Photogrammetric Engineering*, September 1954, 605-10.

<sup>5</sup> Periodic publication of the map in revised form is planned.



survey type), but there is much of larger scale in addition. A further point of importance is that the cost of these prints, to purchase, is usually insignificant compared with that which would be needed in order to obtain the same information by field observation.

Apart from Egypt and the Sudan<sup>1</sup> where the scope is apparent, one may urge the claims of less familiar fields: there is Africa south of the Sahara, where the known types of site run through the whole gamut<sup>2</sup> of hill forts, linear dykes, cultivation terraces, large cairns, etc., with a string of trading-town sites down the east coast. Then there is Aden and the Hadramaut,—or in short the lands along the sea route from the Classical World into the Orient, which, unlike the trans-Asian land route, is still accessible to western archaeologists. Most of the available photographs are of small scale, but preliminary examination showed me some interesting indications.

If the potentialities needed any further proof it could certainly be given from opposite ends of the earth, America and Central Asia.<sup>3</sup> Air reconnaissance in South America<sup>4</sup> is faced with monuments on a scale comparable with those of the Near East, and the problem is essentially that of the 'total mapping' of cities, temples, frontier walls and so forth,—preserved above ground under dry-zone conditions. Here, the scope is well-known and it is only a matter of opportunity. But in the U.S.A., especially the eastern half, the problem is largely in terms of sites comparable with those of prehistoric northern Europe;—in fine, earthwork archaeology, with the majority of the sites under the plough today. Here is a field of special promise and suitability, and one which has still to be exploited from this point of view. Although there has been great interest in the techniques practised in Britain, flights specifically for archaeology have been only occasional in the United States, and little has been published on air photo sites. However, it is of course agreed that the crop and soil marks which will reveal buried sites are there to be found, and that the extensiveness of modern cultivation must have reduced many earthworks to the state of 'buried landscapes'. In this connection, a successful use of air archaeology was made by Glenn A. Black at Angel Mounds, Indiana, where the ditch and other traces of a big Mississippi village were located. In addition a botanical analysis was made of the grasses, etc., which caused the markings. There are lines suggestive of crop-marking to be seen on a recent vertical photo<sup>5</sup> which shows the interior

<sup>1</sup> Together with the Fezzan (ancient canals, cairns, etc.), and parts of N.W. Africa, to which Sir Mortimer Wheeler has drawn attention, *Rome Beyond the Imperial Frontiers*, 1954. Cp. *Kush*, III, 1955, pls. XIII-XIV.

<sup>2</sup> For examples see *Antiquity*, 1950, 96 and pls. VII-IX (cultivation terraces in South Rhodesia); 1953, 215 and pl. III (earthwork fortifications at Bigo, Uganda).

<sup>3</sup> Or from the Antipodes; for the report of an account (by Dr. Palmer in 1947) on the air photography of ancient sites in New Zealand, see *Antiquity*, 1949, 223.

<sup>4</sup> The best account is still *Peru from the Air*, by Lieut. G. R. Johnson (*Am. Geogr. Soc.*, 1930); for other references (e.g. to Central America), O. G. S. Crawford, *Archaeology in the Field*, 215.

<sup>5</sup> A. R. Kelly, *Archaeology*, Spring 1954, 22-7. Etowah contains one large and two small temple mounds. Sites of larger villages or townlets are known, with more elaborate plans, for which air mapping should prove of still greater advantage.



of the Etowah site, now under the plough. This large village in Georgia, contemporary with medieval Europe, has surrounding ditches enclosing 40 to 50 acres, and is now being excavated. On the air view the outlines of its partly levelled earthworks in ploughed fields oddly remind us of some strange form of prehistoric European site.

But the most remarkable instance of U.S. air archaeology in recent years known to the present writer was the discovery at Poverty Point in northern Louisiana in 1952-53, reported by James A. Ford.<sup>1</sup> Surface finds of stone implements had been made at this spot for many years. Nearby is a huge earthen mound, its top 70 feet above the plain; this had been believed natural but drilling has now proved that it is artificial,—as prodigious as Silbury Hill near Avebury. Adjacent to this mound, the study of air photos revealed an extraordinary series of earthworks, no less than three-quarters of a mile in diameter, consisting of six concentric banks and ditches,—or rather their remains, for the area is under cultivation. Mr. James Ford, who has tested this giant earthwork by excavation, modestly observes that this site had not previously been discovered by observation on the ground simply because it is on too large a scale. The broad low banks have been reduced to a height of 4 to 6 feet, and straight roads through them radiated from the central open space. It seems that the original layout may have been eight-sided and that the Arkansas river channel eroded part of it. The age of the Poverty Point complex is not yet settled, but arguments from geology and radiocarbon dating have suggested a period of 400 B.C. or earlier (in the Late Archaic to Early Woodland period). One may marvel that so vast an earthwork could be built by peoples of a pre-pottery culture.

Two conclusions may be stressed. Ford's discovery resulted from making use of the ordinary survey photos in the Print Library of the Mississippi River Commission,—a further instance of the importance of extracting the archaeological data that are latent in such collections, even though many of the photos are of small scales. Further, it is clear that air archaeology could very effectively aid work on foot in studying, mapping, or locating innumerable types of mounds spread over the great expanse of the eastern half of the United States,—shell middens, burial tumuli and ritual mounds,—besides the outlines of ditch-enclosed prehistoric villages.<sup>2</sup> In the south-west, the aerial mapping of the remains of the sites of ancient Pueblo villages, some well over a thousand years old, offers further opportunities of a different kind.

By way of conclusion one other instance of air archaeology may be noted, particularly as the results are not widely known. The Russian expedition which worked from 1945-48 on the Kizil Kum steppe, south-east of the Aral Sea, made

<sup>1</sup> *American Antiquity*, XIX, January 1954, 282-5.

<sup>2</sup> I am very grateful to Mr. John Witthoft of Pennsylvania State Museum, who used air observation successfully at the Valley Forge Encampment, for advice on these matters. (For regional types of site, see *Archaeology of Eastern United States*, ed. J. B. Griffin, University of Chicago, 1952); the student of European prehistory will find intrinsic interest in their structural remains, *qua* field sites.



use of aircraft in studying the rich remains of early civilisation which received a death-blow from Genghiz Khan in the 13th century. About 30 air photos are included in S. P. Tolstov's account published in 1948,<sup>1</sup> giving oblique and vertical views of the sites of walled cities, mostly square or sub-rectangular. A later book by the same author, in 1952, contained about a dozen additional photos of such sites, with their gridded street-plans still well-preserved by surface earthworks. Yet another volume by Tolstov, also published in 1948, dealt with the 1937-40 expedition to this region, 'Old Khorezm'. He distinguishes (i) the prehistoric period of 'hut-fishermen'; (ii) the period of the 'Thousand Cities', quadrangular fortified settlements, some 1,000 × 700 metres:—a highly complex system of irrigation was developed, apparently from at least c. 500 B.C. (contemporary with the Achaemenians) and declining in the early centuries A.D.; (iii) the period of the 'Ten Thousand Castles', 6th to 8th centuries A.D.; (iv) the period of the 'Great Khorasmians', including many large forts, especially in the 12th century, before the destructions by Genghiz. Sites from periods ii-iv are illustrated by air photos in the other two books, and remote though this area may seem its fortunes have connections with far wider questions in archaeology and history.

No more. Everyone could add his quota to a chronicle of eligible areas,—to list those unexplored would labour an obvious point. It is more profitable to show that the air arm of archaeology has a universality in its methods and application. As with the modern techniques of excavation now spreading round the world there is no secret in the recipe: there are simply proven methods to be used at the right place and moment.

### CONCLUSION

And now to the summing up: *nemo silens placuit, multi brevitare*. If it be true that all specialists tend to eulogise the importance of their particular field, it is also freely granted here that, whatever their merits, the archaeological methods described have ponderable disadvantages,—in particular expense, the facilities required, and restricted usefulness in many areas. Moreover, topographical study is only a first stage, however necessary, towards the understanding of ancient communities. Its limitations are known and accepted. Even where the evidence is most complete (as when, for instance, all the Roman tree pits and vine trenches in a definable area have been found and counted, their yields estimated, and the boundaries mapped with a care that would have delighted the *agrimensores*) much is missing and must be supplied from other sources. Excavation is naturally the next, or better the concurrent, stage; and a large part of air archaeology is, in a real sense, 'path finding' for excavation,

<sup>1</sup> *Roboti Khorezmskoi Ekspeditsii, 1945-8*. I am very grateful to Professor Tolstov for copies of his works, following his visit to Oxford in 1956.



economising and directing its effort. Yet, as we all know, even the latter is limited in its powers by its material. If in some future age the ruins of our finest 17th century buildings were to be dug up they could not give that intimate knowledge of men as individuals that we get from Aubrey or Pepys.

Since, therefore, all synthesis in the reconstruction of ancient communities has an artificial element, not only a recording but also a creative spirit is called for. Air archaeology is only one of the means towards attaining the comprehensive data necessary, but we know enough of the circumstances that regulate its successful use to gear it deliberately to wider policies of research, concentrating first on key sites, problems, and regions. Throughout this book the importance of planned action has been stressed, and today this normally means action by government or by national bodies and societies. Air photography is, *per se*, particularly suited to action planned on an extensive scale. Certain types of site that have a recognisable form or plan and a wide distribution invite the general search that is practicable from the air. The method is at its most effective when faced with remains that are of formidable extent (e.g. ancient field systems) or with planning that follows a system (e.g. Roman defensive works, ancient cities, etc.), or with regions having some natural or historical unity (in highlands or lowlands) to be studied as a whole.

In the right circumstances the results can be overwhelmingly rewarding. Reviewing Poidebard's first volume<sup>1</sup> Sir George Macdonald wrote: 'Its significance can best be measured by a comparison with the relevant section of the article *'Limes'* in Pauly Wissowa's *Real-Encyclopädie*. . . . This is a masterly summary by Fabricius of the facts accessible in 1926, but at almost every turn the writer finds himself hampered'. A few roads and isolated finds, a few hints from inscriptions and scanty references in ancient literature, 'did little more than make darkness visible. On Père Poidebard's map the whole outline is as clear as noonday, and we have before us in its completeness one more monument of the genius of Rome'.<sup>2</sup>

In a big survey the number of photos will run into thousands. In future it might well be a wise policy for several archaeologists to combine their efforts in the photo interpretation and field work, just as scientists work as a team to hasten a complex piece of research. A mass of new detail quickly accumulates when the reconnaissances are systematic. Interim reports will give the gist, but to complete the study and add the excavation requires a sustained effort over some years. Poidebard's researches began in 1925 and were published in 1934. These were based on photos taken by hand as the sites were gradually found singly, by visual reconnaissance. Baradez made faster progress (although admittedly the region searched was smaller) by relying to a great extent on the

<sup>1</sup> A. Poidebard, *La trace de Rome dans le désert de Syrie. Recherches aériennes 1925-32*, Paris, 1934; cp. also Poidebard and Mouterde, *Le Limes de Chalcis: organisation de la steppe en Haute Syrie romaine; documents aériens et épigraphiques*, Paris, 1945.

<sup>2</sup> *Antiquity*, 1934, 373-80.



block coverage given by vertical photography taken automatically, using visual reconnaissance as a supplement.

Planned programmes of reconnaissance will always be exceptional, but in this country and some others there are, fortunately, opportunities for individual initiative, and not a few discoveries of importance have been made by R.A.F.<sup>1</sup> and private pilots. Indeed we know that, on occasion, the skilled amateur can be unsurpassed in this field. Many of Major Allen's photographs, for example, although taken upwards of twenty years ago are not likely to be excelled in the foreseeable future. Members of flying clubs might be able gradually to explore their own region in detail, obtaining the full benefit of the extra facts added in consecutive seasons by changing crops and other factors. The ideal method from every point of view would be to combine, working in teams; basic training of the eye in archaeological observation could be quickly acquired. Through the work of Crawford, Poidebard and others, the principles are clearly established,—and, in a phrase of Tennyson's, 'most can raise the flowers now, for all have got the seed'. There is a wide range of objectives within the scope of individual enterprise which could make contributions of real weight to archaeology;—as for instance, to piece together the field system that surrounded a Romano-British farm, giving a definable economic unit,<sup>2</sup> or, to look abroad, the discovery of an Iron Age farmstead in north-west France that could advance the study of the period as much as that at Little Woodbury has done in England.

A treatise on method tends towards scientific detachment, and more personal feelings shall have the last word. Come what may, exploration carries its own intrinsic rewards,—the pleasure of the unexpected, hopes realised by facts, creation in place of negation. And there is in the first moment of discovery from the air a real sense of triumph that inanimate remains should have so much of human life to show.

<sup>1</sup> See for example *Antiquity*, 1954, 168 and pls. VI-VII; views of 'Celtic' fields in Shropshire,—among the first recorded from this area,—found and photographed by Group Captain Livock.

<sup>2</sup> I.e. on the lines of the photograph of the Roman house at Little Milton, Oxon., showing its surrounding field-enclosure ditches as crop-marks (St. Joseph, *J.R.S.*, 1950, pl. VI, 2); cp. 'Celtic' fields in 'immediate proximity to Roman villas' on Langton Wold, East Riding, Yorks. (*J.R.S.*, 1953, 95).

A primary objective of British (and Continental) archaeology at this moment should be *to find and map the field-system of several Roman villas*. This lacuna is seriously impeding the advance of historical knowledge. The problem embraces units ranging in economy from a grange such as Chedworth to a cottage such as Iwerne, and in tradition and time from Belgic forerunners of Romanised farms (e.g. Welwyn). Naturally, we can expect that their fields will differ too, with regional variations. (Since this note was written, Mr. Collin Bowen has begun to examine the evidence from Dorset, *Archaeological News Letter*, VI, no. 2, 1955, 35-40).



## CHAPTER II

# RECONSTRUCTING A PREHISTORIC LANDSCAPE: THE FIRST PHASE

*Scope and Method 85, Techniques Used in Apulia in 1945 91, Vegetation Markings and Measurements Considered 93, Specimen Sites 99, Limitations of Photographic Evidence: the Problems Assigned to Excavation 103, Neolithic Seafaring 105.*

### SCOPE AND METHOD

IN THE previous chapter I discussed the general principles and technical methods which guide the archaeological interpretation of air photographs, with instances from individual sites of differing kinds.

Logically, the next step is to describe these principles and methods at work in the study of a whole region. Such an analysis required not a mere handful of photographs but a series numbering thousands used with the deliberate aim of extracting new facts from which to reconstruct a social landscape, where none was known before. The antiquity of this particular example, in South Italy, was some 4,000 years. But in research, it is one thing to formulate the objective clearly and quite another to attain it. The first requisite is patience. Air photographs are pictorial documents that require attentive decipherment, and the clear-cut opinions on the evidence I am now to describe were only reached after prolonged examination of *minutiae*; often patterns of tiny lines faintly defined. As material for detection and reasoning they have their own interest, but a description of every detail would be as inappropriate as a tabulated list of every note in a musical score! The elucidation of individual markings often consumed much time, and the reader shall be spared these labours. Fortunately, however, in their overall outlines the prehistoric settlements were always clearly demonstrable beyond doubt.

I propose to concentrate in this chapter, on the period of study immediately following discovery, with examples of the strength and also of the limitations inherent in the evidence during this 'first phase' of research. Speaking generally, its duration may be from several days to several years, depending on the complexity and unfamiliarity of the new sites, and on the feasibility of testing the preliminary conclusions by the systematic excavations which initiate the 'second phase' of study. In the case that concerns us here, the 'first phase' interpretation occupied much of my leisure for more than three years. This was admittedly exceptional, and resulted from the quantity of the discoveries, the disentangling of sites of different periods, the need for special care in the selection



of points for test-excavation, and the preparations for a small expedition which had to be launched overseas. Such complications, however, serve all the better to show the kinds of problems which accompany this stage of the work; and they may be of some guidance in comparable circumstances of aerial discovery, on a still greater scale, that may be expected in Africa and Asia particularly. There is an urgent need in many countries for an advisory panel on Air Photography to aid the archaeological services.

Among the most fruitful discoveries brought about by air photography during the Second World War have been those on the Foggia Plain (traditionally called the *Tavoliere*), in the province of Apulia in South-east Italy. Great numbers of prehistoric, Roman, and medieval sites have been identified in this region which, in spite of its topographical importance and rich historical associations at the heart of the Mediterranean World, had been believed to be almost devoid of archaeological interest. The geographical setting<sup>1</sup> of the Foggia Plain is shown on Fig. 5.

As a further consequence, too, these discoveries have had an importance beyond their regional interest and the gap they filled. To each of the three periods they had contributions of far wider significance to make, bearing upon major threads in the fabric of European archaeology and history. Such new sites and the finds excavated from them illustrated, in tangible form, three principal stages in the growth of a European peasantry, from its formation and over the last 4,500 years. In a single chapter, however, it is only practicable to sketch the preliminary reconstruction of one of these three ancient landscapes, and I have chosen the oldest.

I shall not in any way anticipate here the details, or conclusions, derived from the systematic test-excavations and field survey conducted by the official expeditions sent out in 1949 and 1950. These are embodied in my definitive account now in preparation as a Report of the Research Committee of the Society of Antiquaries. Instead, and to complete the clearing of the ground in readiness, I wish simply to draw attention to a few aspects of these discoveries which were discussed in my earlier<sup>2</sup> preliminary accounts, written before the

<sup>1</sup> The Tavoliere is the largest area of plain in Italy south of the Po Valley.

In the Neolithic, and in many subsequent periods of its history, its outlook and affiliations lay eastward and southward rather than with the mountain hinterland of peninsular Italy. I have orientated the map on fig. 5 to express this relationship. Such departures from the ingrained habit of looking at the globe immutably northwards are often worth practising; as, for example, when studying the history of the Asian steppes from the viewpoint of the nomads themselves, instead of from that of the peripheral civilisations.

Comparing the Adriatic and Aegean 'gulfs' in their relation to the expansion of Neolithic cultures it will be seen that the maritime plain of Apulia lay in a position analogous to that of Thessaly but at one further remove from the Near East foci. Prof. Sir J. L. Myres had suggested reasons for the limited use made of the Adriatic by Greek sailors later; one is that they probably found native seafarers already well-established there (*Geographical History in Greek Lands*, 1953, 146-50). In prehistory the Adriatic has always had the status of a 'poor relation' compared with the Aegean. But the latest discoveries in Apulia redress the balance a little. For Neolithic farmers as seamen, see p. 105 below.

<sup>2</sup> 'Siticulosa Apulia', *Antiquity*, December 1946, pp. 191-200; and 'Buried Landscapes in Southern Italy', *Antiquity*, June 1949, pp. 58-72; and in the *Illustrated London News*, 29 April 1950, pp. 674-5.



expeditions took the field. This chapter, then, is devoted to the special kinds of problem affecting the initial stage of the work, and to explaining how the primary evidence is obtained from the photographs:—in a word, to ‘method’

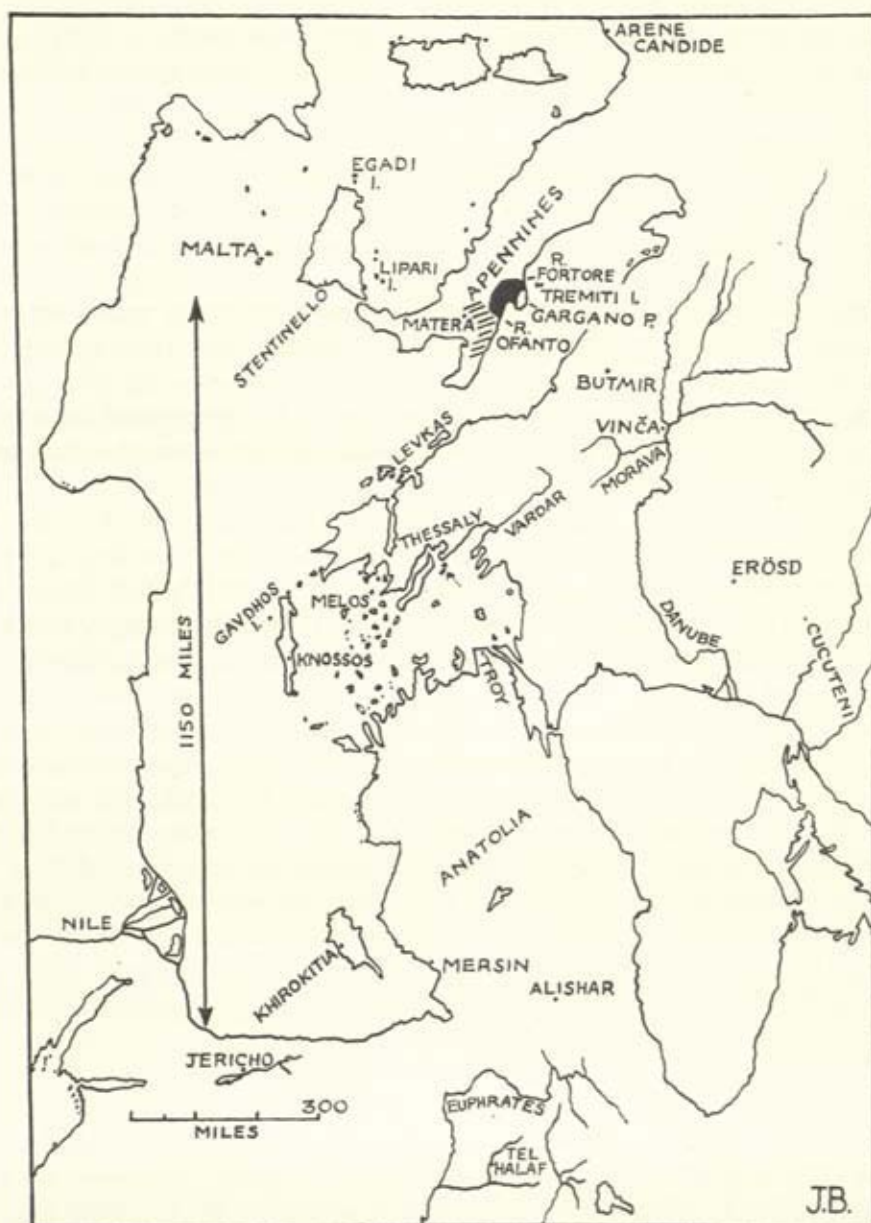


FIG. 5 Neolithic Apulia and its approaches, looking west along the Mediterranean from foci farther east. The extent of the Tavoliere di Puglia, where over 200 ditch-enclosed settlements have been found from the air, is shown in solid black; an adjoining area with sites of the same type is shaded.

during this first phase, treating it in greater detail than is practicable in the Report on the expeditions, in whose pages priority has necessarily been given to the mass of data which was furnished by work in the field. To review the early doubts and difficulties occasioned by the discoveries, in a sequence of real events instead of discussing theoretical instances, will carry a useful lesson in itself. Also, it will serve very well to illustrate and introduce some of the methods of study to be followed in later chapters. For the prehistoric settlements, whose plans were revealed in such numbers, give an unusually clear picture of the nature of a 'Buried Landscape'. The circumstances which made possible the discoveries on so large a scale were of course exceptional, but even in peacetime extensive programmes of aerial photography are becoming more and more frequent. We must always look to the future.

When the first phase of study was finally completed there was a grand total of more than 200 settlements. All had been found from the air by surface markings above their silted-up enclosure ditches, giving plans of a distinctive form with Neolithic characteristics. They could be measured and planned with the greatest accuracy and in much detail, direct from the photographs. Some settlements were of considerable size, up to 800 yards across.

This is one of the densest concentrations of prehistoric settlements yet known in Europe, compressed as it is within an oval plain about 30 miles across at the most and 55 in length, between the R. Fortore to the north and the R. Ofanto to the south (natural frontiers, beyond which the terrain changes completely). But I feel confident that even this total could be substantially increased, and probably almost doubled, when it is possible to undertake further systematic air photography, based on the experience and results obtained and the methods already proven. Such a programme of aerial research would entail intensive work during a few critical weeks in early summer, preferably in two or more successive years, to cover fields that were fallow or uninformative for various reasons when my original flying-programme in 1945 was executed. But careful planning is an essential preliminary. It should be emphasised most strongly that such photography must be carried out under the correct local conditions and with a full understanding of the experience already gained, if it is to be successful and of scientific value. Without this, it would be wasted effort and expense.

Even before the first photograph was taken there were good reasons for expecting that conditions on the Foggia Plain were most favourable to the appearance of vegetation-marks, indicating the presence and plan of archaeological sites beneath them, obeying the same logical principles as those so fully demonstrated in England by O. G. S. Crawford, G. W. G. Allen and others. But it was not until the time of the Armistice early in May 1945 that Williams-Hunt<sup>1</sup> and I had leisure to fly together in order to test our expectations experi-

<sup>1</sup> I should like to put on record, again, the important part which the late Peter Williams-Hunt played in the initial discoveries. His death, from a tragic accident in Malaya in 1953, cut short a career already full



mentally. The Tavoliere was already intimately known to us, from a long sojourn on it. As fellow officers in the same Army unit, we had for years discussed, and looked forward to, just such an opportunity 'après la guerre finit'. For a brief space the material resources were available, but we knew that they would soon be re-deployed and there was no time to be lost. We were able to take our oblique photographs during air-camera tests, and arranged for vertical photography of the same areas as part of the routine practice which Royal Air Force units had to perform locally. Thanks to the generous and understanding co-operation of the military authorities, archaeological evidence of the greatest scientific value was thus recorded and preserved for subsequent examination in detail. All too soon the crops were harvested and many sites resumed a temporary invisibility in a disappearance as sweeping as the cleaning of a school slate. But by immediate action a great deal was accomplished in the interval, helping to dispel in us and others that oppressive sense of emptiness and anti-climax which descended when operational activity ceased.

Sternly objective though archaeology tries to be, the interpretation of the past also demands a true feeling for the 'spirit of place', to bring one closer to the heart of the matter; and such impressions may often vigorously augment or re-orientate the strictly scientific method to its advantage.

On the Tavoliere today, the sense of unlimited space and sky and freedom of movement is saved from monotony by the blue line of mountains along the horizon that gives a land-locked security and intimacy, by the fierceness of light and colour, by the sharp contrasts of winter cold and summer heat, by the pleasures of a short intense spring and a renewal of spring in autumn, by the long welcoming seaboard that soothes the eye and modifies the impression of a parched hinterland;—all these and other things combine to produce that form of harsh yet stimulating landscape which is so often, and so well, depicted in Edward Lear's Mediterranean drawings. Though forbiddingly bare today,<sup>1</sup> the Tavoliere is more capable of flourishing than its notorious reputation in recent centuries would ever suggest;<sup>2</sup> for, fundamentally, it is a hopeful environment

---

of achievement and was a great loss to archaeology and anthropology. Details of his work and writings will be found in *Antiquity*, 1953, 170-2 and *Man*, 1953, pp. 175-6. In June 1945 he was posted to the Far East, where characteristically he lost no time in making further aerial discoveries on an extensive scale. The preservation of the photos of the Apulian sites fell to me, and subsequently they were officially transferred to the University of Oxford, where they have proved of unique value for teaching and research. Grateful acknowledgement is due to all those who helped to ensure this.

<sup>1</sup> Apart from the olive-groves encircling the towns, the Tavoliere today is almost devoid of trees. But there remains a single localised and incongruous zone of oaks and scrub around the ancient pilgrimage-shrine of the famous black Madonna dell' Incoronata, at the centre of the plain. This is the last remnant of the patches of light woodland which survived on parts of the Tavoliere in the early Middle Ages, and, in particular, of the hunting chase of Emperor Frederick II. This wood owes its modern preservation primarily to the sanctity of its association with the appearances of the Madonna in an oak tree here, which led to the building of this isolated woodland church.

<sup>2</sup> The 18th and 19th centuries saw the Tavoliere at the nadir of its fortunes. Lenormant gives an excellent regional history, in his *A travers l'Apulie et la Lucanie, notes de voyage*, 2 vols. 1883. 'Elle est animée seulement pendant les mois d'hiver par les immenses troupeaux qui descendent des montagnes; le reste d'année,



if properly handled. To the natural potentialities for simple farming, its Neolithic settlers (like those on the plain of Thessaly) were certainly not blind.

Sympathy with the modern landscape certainly quickens the understanding of its forerunners, yet we must take care that imagination is bridled as well as spurred, and we cannot regard the terrain, by itself, as all-powerful. Admittedly, the guiding-reins of topography have lain heavy on the past history of this region, but, on the other hand, it has also provided the setting for a succession of man-made landscapes of strongly differing kinds. In the Neolithic, Roman and early Medieval periods, the Tavoliere thrice radically changed in appearance, when life was active and relatively prosperous; and each of the characteristic landscapes thus created can be traced and re-constructed with the help of the air photographs. True, the region has usually relapsed, and in spite of its distinctive character it has never had its major painter or poet. Yet in the 13th century it pleased Emperor Frederick II,—the greatest European ruler of the time,—sufficiently to make it a favourite centre for his brilliant court. Had his dynasty survived, the Tavoliere might well have become famous. But as events have turned out it is only a vaguely-known backwater even to most Italians, a transit route for hurried sportsmen, tourists and pilgrims.

Why should the Foggia Plain (it may be asked) prove so revealing? The explanation is simplicity itself, and points the way to potentialities in comparable areas in other parts of the world. The mean annual rainfall at Foggia is a mere 18.6 inches (falling to .6 inch for July), or only very little more than Tunis which has 16.6 inches a year; Rome, by comparison, has twice as much, 35.5 inches. Over the rolling expanse of this miniature steppe the covering of soil is often thin above the rock which in texture resembles a soft limestone;—in summer its parched earth calls to mind the classical reputation of *siticolosa Apulia*.<sup>1</sup> Moreover, the modern landscape is monopolised by immense stretches of arable land, without a hedge in sight. Such conditions of aridity, soil, and cultivation combine to produce crop-markings of unsurpassed clarity above ancient ditches and all those features of the 'buried landscapes' which can promote or retard growth above them, for reasons already explained (p. 11 seq.). There are, also, numerous reactions in height and growth on the part of wild flowering plants on stubble and pasture, and the course of ancient ditches may sometimes be delineated as brilliant lines of colour. These 'weed marks' were an important factor in aerial discovery.

elle demeure un désert où l'on n'aperçoit pas un seul être vivant. Le sol en est d'une grande fertilité; mise en culture, elle pourrait être le grenier de l'Italie entière, ou bien devenir facilement un verger de vignes et d'arbres fruitiers'. In its post-medieval form, Pastoralism on the Tavoliere was an extreme and evil exaggeration of one aspect of the economy of the plain which had existed since Classical times (and no doubt earlier still). We should not allow this late development to obscure the ancient importance of cultivation in this area, as some authorities have done. We can now show that its soil had been turned to good advantage in the Roman and early Medieval periods (cp. my outline of this new evidence in *Antiquity*, June 1949).

Corn, vines, and olives (the '*trimoda necessitas*', so to speak, of Mediterranean cultivation) are now being restored successfully to the Tavoliere, as Lenormant acutely foretold.

<sup>1</sup> See Horace, *Epodes*, III, 16.



## TECHNIQUES USED IN APULIA IN 1945

The concern of this Chapter is with the first steps in the air archaeology of an un-trying region. There is no prescription for universal use, but the following policy for an area of c. 60 × 30 miles proved very effective. Beginning with visual reconnaissances we flew at about 3,000 feet, forming a crew of three (pilot, cameraman, and observer). When Williams-Hunt and I had familiarised ourselves with the various types of buried sites to be found, we began oblique photography, using a hand-held air camera of 8-inch focal length at a height of 1,000 feet from a Fairchild high-wing monoplane. For the vertical photography, air cameras of 20-inch focal length were used from a height of 10,000 feet, giving a photographic scale of 1 : 6,000 (about 10 inches to 1 mile).<sup>1</sup> This scale gave excellent results, both for a detailed study of markings and, later, as a key to excavation. The cameras were operated automatically, and were mounted 'split', taking a continuous series of photos in two parallel strips, to give maximum coverage and overlap for stereoscopic examination. Such is the normal method now used in most countries for routine aerial mapping. In Apulia we found that, archaeologically, this vertical survey was of crucial importance, filling the gaps between the widely scattered points covered by the obliques,—thus adding almost ten times as many more sites,—and co-ordinating patterns of markings which were of great extent. Finally, when the overall picture of the region was established, we completed our reconnaissance with further obliques of the most promising sites. For oblique and vertical views are complementary, much as sections and plans are in excavation.

Taking a retrospective glance at our 1945 reconnaissances, suddenly rewarded by an unparalleled display of buried sites, extensive, complex and novel, I feel no hesitation in owning that at the start their identities were only to be guessed at, until partly reasoned out by photo interpretation. When we began, the archaeology of the Tavoliere was little known, and air photographs of comparable sites in Italy did not exist. But we made a particular point of observing and recording markings of all kinds impartially, and their nature became clearer after further detailed study of the photographs which was begun later in 1945 while I was a member of the Sub-Commission for Monuments, Fine Arts and Archives of the Allied Commission for Italy.<sup>2</sup>

First, the positions of hundreds of new sites had to be transferred from the

<sup>1</sup> In passing it may be noted that some of the archaeological crop-sites were so clear that they could be recorded from a height of 5 miles. Photos of about 1 : 10,000 scale gave tolerable pictures of such markings; at 1 : 16,000 they were still visible, but too small for detailed interpretation (except the largest sites).

<sup>2</sup> It is a pleasure to acknowledge the many kindnesses received from Italian archaeologists at that time, and particularly from Professor P. Barocelli, at that time Director of the Museo Preistorico-Etnografico in Rome, who gave me valuable facilities for studying Italian prehistoric material in 1945. Thus was re-established an old link between British and Italian prehistorians in Apulia; for, just forty years before, another Oxford archaeologist, T. E. Peet, on his first field-research, was devoting himself to the study of the Apulian Neolithic at Matera, with his friend Ridola—, a study culminating in his famous volume on *The Stone and Bronze Ages in Italy*, Oxford, 1909.



photographs to maps. The lines of some of the crop-markings intermingled in labyrinthine detail like a tangled skein of wool, while others ran across country for a considerable distance; consequently, the work of transference was often very laborious. Further, it was physically impossible to find space on maps to record all the crowded crop-markings of the smaller archaeological features, even on maps of the largest existing scale (1 : 25,000; just under  $2\frac{1}{2}$  inches to the mile). The photographs, by contrast, had scales several times larger (ranging from 1 : 6,000 to 1 : 12,000); and, frequently, the only method of planning the sites in detail was to take special tracings direct from the photographs. 'Kodatrace', a truly transparent material, was found to be best for this. Another difficulty, and one that imposed many unwelcome delays, was that the then-existing 1 : 25,000 maps were no longer accurate. Big land-reforms by the State in the last twenty or thirty years have changed most of the Tavoliere from pasture to cultivation. In every part, old trackways and boundaries have disappeared and have been replaced by immense featureless fields, often making it very troublesome to relate the photographic data to the existing maps. The British 1 : 50,000 G.S.G.S. maps were useful, but we required a larger scale.

The bulk of the photographs were verticals and all of these were examined stereoscopically, and each of them very many times. Every one of the bigger settlements received a total of several hours of intensive photographic study during the course of the 'first phase', but this stereoscopic examination was the most important single operation in the whole work at that stage (cp. p. 59). While it was in progress, 'comparative cover' was always studied, in order to note any significant additions or alterations to the appearance of a site at other times of the year or under different conditions of cultivation. Again and again such comparisons proved of the greatest value for the correct understanding of important but poorly-defined crop-markings. Next, a settlement would be measured (in the manner already explained on p. 58), to find not only its maximum overall dimensions in terms of hundreds of yards, but also the size of the smallest features:—for example, even the crop-mark width of ditches as small as 4 feet across! After this, the chief characteristics of the site-plan would be compared with those of its nearest neighbours. The problems of particular features would then have to be considered (e.g. why the entrance to a village pointed in this or that direction);—and the environmental setting, as a whole, would be re-examined through the stereoscope, with the primary emphasis on topography rather than archaeology. Obviously one could not go from England to Apulia to settle each doubtful point, but prolonged practice in stereoscopic work combined with a lively recollection of the terrain enabled one to visualise the 'lie of the land' or the gradient of a slope almost as clearly as if plodding over the ground on foot. Stereoscopic work of this kind should form an obligatory part of the training of every archaeological student.

Implicit in such work is the essential requirement of complete familiarity with the appearance of *all* the ordinary, as distinct from the archaeological,



features of the landscape,—in order that the former can be recognised at a glance and fully understood, while the latter are sifted from them. The first precept in the interpretation of ancient landscapes must be:—Study the *living* landscape in its smallest particulars and *see how it works*. Nowhere is this more necessary than in new areas 'opened up' archaeologically for the first time by air photography.

There followed an interval while the discoveries were reviewed in the light of data from archaeology, history, geography and geology. The next step was axiomatic: to test the evidence and preliminary conclusions by systematic field-work and trial-excavation. This stage was reached in 1949-50, and formed the first systematic programme of archaeological investigation based on data supplied exclusively by air photographs ever to be conducted in Italy, as well as the first British excavations there for a number of years. All this was only made possible by the most helpful attitude of the Italian authorities; and the campaigns were prepared and executed under the aegis of the Apulia Committee of the Society of Antiquaries, with the aid of Sir Mortimer Wheeler as its Chairman,—a continual source of inspiration and guidance. To this sustained and indispensable support was added that of the Pitt Rivers Museum in Oxford, and the British School at Rome, while generous grants were made by the Society of Antiquaries, the British Academy, the Craven Committee at Oxford, the Trustees of the Leverhulme Fund, and others. Although their substantial help and encouragement will be chronicled in the substantive Report on the expeditions, I cannot refrain from taking this additional opportunity of expressing the gratitude that is due.

The extensive finds, the results of the test excavations, and the detailed analysis of the mass of crop-markings examined on the ground, belong as of right to the forthcoming definitive report, and would in any case lie outside the field of this chapter which is concerned with the manner of the original discovery. However, Interim Reports<sup>1</sup> on the first season's work are available, to add confirmatory detail to this brief outline of some of the initial problems of the air photographic evidence in the pre-excavation phase.

#### VEGETATION MARKINGS AND MEASUREMENTS CONSIDERED

Considered as a whole, the entire group of settlements appeared remarkably homogeneous. This impression became very strong when one had examined their plans individually and collectively, and then compared the details of lay-out and siting.

Examination of the air photographs showed at once that most of the sites lay on level ground in positions of little or no defensive strength, and often some distance away from water (and usually only small and variable streams at

<sup>1</sup> 'The Apulia Expedition: an Interim Report', *Antiquity*, June 1950, pp. 84-95; and *The Times*, 28 August 1950.



the present time). Towards the back of the plain, however, many settlements were placed close to the edges of the numerous low escarpments and spurs; but only in some of these was the line of the escarpment embodied in the plan defensively as one of the sides of the settlement. Occasionally the plain is diversified, even where flattest, by some slight hillock or undulation, and such differences of a few feet were unerringly picked out by Neolithic settlers.

Similar positions were also sought out by medieval and modern farmers in order to raise their dwellings a little out of the malarial air, and so it is not uncommon to see (on the photographs) an old farmhouse neatly surrounded by the crop-marks of the ditches enclosing a Neolithic settlement on the same spot.

Examination of the photographs made it clear that the plans of these settlements were all of cognate kind, and that no other class of site existed with which they could be confused. Such sites could be seen, too, on operational air photographs taken in 1943 which were studied with care, thus confirming that the crop-markings in 1945 were not in any way an exceptional occurrence. Every site was enclosed by from 1 to 8 ditches,—habitually variations on a roughly circular outline. Some of the smaller and most of the larger sites had their ditches placed concentrically, and in almost every case the planning had been symmetrically carried out. The stereoscopic examination of the photographs showed that *no trace of any surface earthworks, of bank or ditch, survived above ground* which could have led to their discovery in the absence of the aerial survey.

The larger sites, big enough to be thought of as 'villages', were enclosed by multiple<sup>1</sup> ditches, usually placed fairly close together, and revealed as usual by vegetation-marks (e.g. Plate 28). Their plans are notable for symmetry, all the more remarkable in sites of such considerable size. Sites of smaller size and simpler form, which may have been based on the single family group as a unit, are normally enclosed by a single ditch, or by two spaced some way apart. But in all outward essentials, to judge from the photographs, they are only lesser versions of the 'village' type. There are many sites of intermediate size, and those lying on the edges of low escarpments have all the characteristics of those on the plain, except an occasional minor adaptation of the plan to the position. Many tons of earth and rock must have been dug out to construct the ditches of even the smallest.

The photographs alone, however, could not define the status of these sites. We had to remember, for example, our own large Neolithic camps in England whose concentric ditches must have required much labour to dig; but it is thought, nevertheless, that these English sites were occupied seasonally, when pastoralists assembled their herds, probably in autumn.<sup>2</sup> On the other hand

<sup>1</sup> Positions of natural strength on the Tavoliere proper are very few. Multiple ditches would be needed to create them. If reinforced with a palisade and/or bank they would have given protection against sudden raids, especially attempts to carry off stock. In common with other Neolithic communities those of Apulia have always appeared un-warlike, if absence of specialised weapons is a criterion.

<sup>2</sup> See Professor Piggott's discussion of the evidence in *Neolithic Cultures of the British Isles*, 17 seq.



there are true Neolithic village sites in other parts of Europe. I mention such uncertainties in order to emphasise again the *essential dependence* of some aspects of air photograph interpretation on proofs from excavation. True, the impression conveyed by the preliminary study of these Apulian sites was that the larger ones could be provisionally termed 'villages', but naturally the smaller were more difficult to classify. The situation was a good example of the doubts and reservations which only excavation could dispel.

However, questions and hypotheses could reasonably be posed. Were the smaller sites equivalent to some kind of primitive 'homestead', or simply for brief seasonal occupation? In either case some variation in the sizes of such sites might be expected. As a working hypothesis for the first phase of study we decided to call some of them 'homesteads' tentatively. Other questions followed from this. Did settlements which corresponded to the homestead of a family unit and to a 'village' group co-exist in Neolithic Apulia? Were the latter just an amplification of the basic plan of the former, to accommodate a larger number of inhabitants? Or were they a later development, evolved from the smaller type?

These are problems to which photographic interpretation by itself provides no conclusive answer, and they can be considered more effectively in the definitive report on the 1949-50 excavations. However, as I pointed out<sup>1</sup> in 1946, my initial ground-examination in 1945 of one or two of the sites at least made possible the preliminary statement that the pottery found seemed to show that both large and small co-existed, whatever their precise social status.

But we must now move from these general considerations to look at the sites in greater detail. Individual variation in the exact shape of the area enclosed was evidently permissible by custom and possible in practice. Nevertheless there were three or four types of settlement-plan for small and large sites which recur fairly frequently (see p. 99 below), and so, clearly, there were accepted tribal norms.

The entrance to the smaller settlements across the surrounding ditches does not appear to have been elaborate, as far as the photographs show. A small outward bulge protruding from the line of the ditch, which is a noticeable feature common to many of the smaller and intermediate sites, may indicate a simple though specialised provision for an entrance. The same feature was noted in the similar Neolithic sites<sup>2</sup> of Murgia Timone and Tirlēcchia, excavated in south Apulia by Dr. Ridola, who interpreted it as an entrance. But entrances of more obvious forms are also to be seen on the photographs, particularly at the larger sites which have their multiple ditches set close together. These entrances are of inturned form. A narrow gap is left unexcavated in the line of the ditch, both arms of which turn abruptly inwards for some distance to form a narrow funnel-shaped approach; and the same method may

<sup>1</sup> *Antiquity*, December 1946, p. 197.

<sup>2</sup> For site plans, see *Bulletino di Paleontologia Italiana*, XLIV, 1924, 121, and tav. V-VI.



be used, too, in passing through each of the several interior ditches. This would be a reasonable arrangement for defence, and particularly for driving large herds in and out of the settlement.

A new addition to Italian archaeology was the discovery of the numerous, smaller, ditched enclosures inside settlements of this type. These enclosures, revealed by vegetation marks of the usual kinds, were circular, penannular or semi-circular in shape. At the start we experimentally called them 'hut-enclosure ditches', but my later preference has been for the more non-committal term 'compounds', probably serving for animals as well as men. The 'compounds' inside the 'villages' do not differ from those in smaller sites, except in being more numerous. It is extremely rare to find these 'compounds' lying *outside* an enclosed site, and there are only two or three possible examples of groups of 'compounds' which seem to lack an enclosure ditch round them. In size the 'compound' can normally range from *c.* 40 to 150 feet in diameter, including the width of its ditches, which themselves produce a vegetation-mark from 4 to 10 feet wide along their course, as calculations from vertical photographs show. Some few are seen to have wider markings, but these most probably represent re-cut ditches. As I have earlier reported,<sup>1</sup> such measurements proved very exact when checked by test trenches excavated at Vignate Fraccareta in 1945. It is of interest to note that the air photographs showed that the 'compounds' inside any one site always have their openings orientated in the same direction. But any planning which existed originally was not of the formal sort in regular rows.

From the photographic evidence it is certainly clear that the Apulian 'compounds' are proprietary, not defensive.<sup>2</sup> In a few, the entrance is narrow but in many cases the ditch only follows two-thirds of the circumference of a circle, and sometimes even less. It must be emphasised that those with wide openings occur in far greater numbers than would be likely if they were only to be classed as unfinished. It is, of course, always possible that some might have been rounded off with a portable barrier of hurdles, etc., which has left no certain visible trace. The diameter of the 'compound' is too great for its ditch to have played a structural part in any dwelling. No definite traces have been identified on the photographs of post-holes, nor of the floors of huts like those found by Ridola and Rellini in similar settlements in south Apulia. The absence of definite signs of the latter is more surprising than that of the former, which would probably be too small to cause a crop-mark. These and other matters, as for example the significance of the great variation in size of 'compounds', are problems which only excavation can answer, and it is wisest meanwhile to suspend judgment on the function of these enclosures. They would certainly seem to be the key to an understanding of the socio-economic

<sup>1</sup> *Antiquity*, December 1946, p. 195.

<sup>2</sup> Neither Ridola nor Rellini ever mention the existence of 'compounds' within their ditched settlements, and it seems that (lacking the assistance given by air photographs) they failed to find them.



life of the settlements. In a large 'village', for instance, one hundred or even more can be identified, while some of the smaller sites scarcely show any. Here and there, local conditions for crop-marking were perfect, and it is of particular importance that we know that at certain sites we can see the precise total of all the 'compounds' that ever existed within. Even so, the air photographs cannot tell us their exact purpose, although indicating the possibilities,—a good instance of the limitations of this form of evidence prior to excavation.

The evidence for dating these sites, obtained from quantities of stratified potsherds excavated in 1949<sup>1</sup> and in 1950, is fully dealt with in the official Report which I have mentioned, and any discussion of this material here would be premature and undesirable. But I should, once again, give a reminiscent glance at one firm piece of supporting evidence for date which existed from the very first days, small in itself but helpful in the initial phase of interpretation. It was supplied by the test-trenches<sup>2</sup> which Williams-Hunt and I excavated in June 1945 across the ditch of a 'compound', inside a large and representative village site, shortly after we had taken our first photographs. The work was efficiently and enthusiastically carried out by men of our Unit as an aspect of its scheme of Army Education, and, at the least, we were able to gain some confirmatory facts to guide future work before the tide of war again separated us.

There was no more than 1 foot of soil above the natural rock. This rock was a calcareous crust 3 feet deep, below which lay bedded yellow sands. It is not surprising that under such conditions of surface geology, magnificent crop-marks result in dry weather. The ditch round this 'compound' was square-cut in section measuring 7 feet wide at the top and 5 feet in depth, dug through the rock and into the sand. Our sections through the ditch contained at all levels a large quantity of a distinctive brown or black burnished pottery, undecorated but of great technical excellence, together with equally typically sherds of a buff-coloured ware of the finest texture, painted in tomato-red with broad bands (in the style termed *fascie larghe*). These types of pottery, although so different in appearance, were undoubtedly contemporaneous. Both are characteristic of the Apulian Neolithic cultural sequence, falling within its middle period, i.e. Phase II as classified by Stevenson<sup>3</sup> in his analysis of the pottery types. These differentiate three chief successive phases within the period. The pottery from this 1945 test-trench, at Vignate Fraccacreta (4 miles S.E. of San Severo), was given to the Pitt Rivers Museum at Oxford in 1946. Sea-shells, too, were found among the potsherds, although the site was 25 miles inland. These shells came from the broad sandy beach which stretches for 35 miles

<sup>1</sup> 'The Apulia Expedition: an Interim Report', *Antiquity*, June 1950.

<sup>2</sup> As earlier recorded in *Antiquity*, June 1949, 62.

<sup>3</sup> R. B. K. Stevenson, in *Proceedings of the Prehistoric Society*, 1947, 85-100; with a valuable bibliography. He emphasised that the paucity of metal finds so far makes a 'Neolithic' classification applicable to all three pottery phases, but that the term 'Chalcolithic' (*Ital.*, 'Eneolitico', covering the transition to the early Bronze Age) can be applied to the last.



between Manfredonia and Barletta, and (in its present form) provides an easy landfall. Military trenching had also unearthed Neolithic pottery from a settlement of the smaller kind. No sherds of any other period were found and encouraged by this we decided to extend our photography to all such sites. Naturally, the evidence from such limited soundings could not be pressed far, but it gave an added incentive to plan for future systematic field work.

During the following year, as the 'first phase' of study proceeded, parallels from south Apulia and south-east Sicily began gradually to define an archaeological context for the new sites, with the facts pointing to a Neolithic setting. And when all the photographs had been thoroughly examined the impression grew irresistible that the period during which such sites were constructed was a long one, in all probability amounting to several centuries. There were many indications to support this latter point: for example, (a) occasional traces of the crop-marks of one settlement over another, (b) the very close proximity of sites of almost identical plan (presumably successive), (c) their distribution, so evenly and thickly spread all across the plain. A few of them showed internal changes of plan, by alterations made in the course followed by their enclosure ditches, though the same basic form of circular or oval plan was always maintained.

The most southerly of the newly discovered crop-mark settlements on the Foggia Plain lies near Cannae, on rising ground across the R. Ofanto which bounds the southern edge of the Tavoliere. This site thus forms a link with the small but similar group already known round Matera, on the Murge (the bare stony downs which form a pendant to the Tavoliere). Professor Drago (then Soprintendente alle Antichità for Apulia) informed me in 1946 that he had also seen a similar site near Vernole in the province of Lecce, still further south. It seems that we may probably infer a distribution of such ditch-enclosed Neolithic settlements throughout S.E. Italy, extending at least from the R. Fortore (the northern border of the Foggia Plain) southwards to the heel of the Peninsula. Unfortunately for the completeness of the pattern of distribution, it was not possible to arrange for air photography of the corn-bearing land on the Murge until the first fortnight of July 1945, by which time the harvest had been gathered for some weeks and the results were therefore negative, although doubtless only for the season. Regrettably, the broad coastal belt of continuous vineyards and olive groves south of the R. Ofanto (at which point the whole modern countryside changes its character) virtually eliminates the possibility of crop-marks. The great mountain promontory of the Gargano also yielded no trace of them.

Taken as a whole, the solid *bloc* of ditch-enclosed settlements on the Tavoliere<sup>1</sup>

<sup>1</sup> Childe reports a similar density among the sites of the Neolithic-Chalcolithic Tripolye cultures of the Ukraine. Occupation for at least two generations seems indicated. But the sites never existed long enough to form 'tell' mounds, and the practice of 'shifting cultivation' due to soil exhaustion is the usual explanation of this (*Dawn of European Civilisation*, 1950 ed., 140). There is no proof, as yet, of the existence of 'shifting cultivation' in Apulia.



is an unparalleled and most noteworthy feature in the distribution maps of prehistoric settlement in the Italian peninsula, which, as a consequence, have a one-sided appearance to say the least. Indeed these air photographs of the Tavoliere have identified a greater number of sites in this limited oval area of *c.* 55 × 30 miles than the total of those recorded on the map of Neolithic sites in Italy, Sicily, and Sardinia prepared by Professor Patroni.<sup>1</sup> He indicated about 170 sites which had produced finds and not all of these, by any means, were associated with any clearly defined type of settlement. From the Tavoliere itself, only a small quantity of scattered finds were in existence prior to the air survey.

### SPECIMEN SITES

Let us now examine the 'primary sources' in more detail. I have selected one or two examples of the newly found sites on the Foggia Plain, to illustrate what can, and what can not, be interpreted directly from the photographs. The work of the 1949-50 expeditions included excavations at similar settlements whose outlines were even more clearly visible.

Plate 25 shows a typical site of the smaller kind, discovered and photographed by Williams-Hunt and myself during a flight on 25 May 1945. Vertical photographs with a scale of 1 : 6,000 were taken a week later, to provide stereoscopic examination and a scale for measurements. The site, which is on level ground with no surface water in the vicinity, stands near the farm named on the map S. Fuoco d'Angelone, 8 miles N.E. of Foggia. Eight miles further to the north the mountainous flank of the Gargano rears up abruptly from the floor of the plain and dominates the scene. Two large enclosures are visible, their ditches now levelled off but revealed by crop-markings above them. Calculations based on the scaled vertical photographs show that the outer oval enclosure measures *c.* 500 × 400 feet overall, and the inner circular one *c.* 260 feet across. A single, inturned, funnel-shaped entrance can be seen (at A), facing south away from the Gargano, and should be compared with other entrances of this type seen on Plates 26 and 28. Such entrances had not previously been found in Italy. It was placed towards one end of the outer enclosure, and this feature of the plan is repeated on many of the sites of this size on the Tavoliere. No obvious entrance to the inner enclosure can be seen.

The plan corresponds to that of the two inner enclosures of the site near the farm of Fonteviva, only 4½ miles to the north-east, of which I published an oblique air photograph in *Antiquity* several years ago.<sup>2</sup> The plan is also fundamentally similar to that of the Neolithic ditch-enclosed site at Murgia Timone,<sup>3</sup>

<sup>1</sup> Cp. Patroni, *La Preistoria*, 1937. Even if the known Neolithic sites in Italy are now double his figure, as is probable, the situation on the Tavoliere remains quite exceptional by comparison.

<sup>2</sup> *Antiquity*, December 1946, Plate 1A facing p. 196.

<sup>3</sup> Ridola in *B.P.I.*, XLIV, 1924, tav. VI.



near Matera, in which the inner enclosure had been withdrawn to the extreme end of the outer one. Our sites on the Tavoliere showed many small idiosyncratic variations on this arrangement. Whether it is correct, in such cases, to think of a 'domestic' inner enclosure, and an outer 'farmyard' enclosure, cannot be determined from the photographs, but only by excavation.

A few other points may be noted. The crop-mark width of the inner and the outer ditch, measured from the scaled photographs, ranges from 6 to 10 feet. If there had been any ditches of small 'compounds' inside this site, their crop-marks would certainly have appeared. As it is, there is only a possible segment of one in the outer enclosure, another (in the background) which seems to overlap both ditches, and one outside the site in the foreground. But it is obviously inadvisable to attempt to explain every minor individual peculiarity from the photographs alone. Plate 25 also provides an example of the markings from later periods which often complicate the prehistoric sites, although readily distinguishable from them. Thus we can also see (e.g. at B) the crop-marks of a buried cultivation-system, produced by the rows of parallel trenches which were dug into the rock subsoil to give extra depth of soil to the roots of vines. This method of planting vines has been extensively practised on the Tavoliere from Roman Republican times until now. It is of great interest that the vertical air photographs revealed large *blocs* of crop-marks of this kind in the vicinity, proving that large vineyards formerly spread over most of the area covered by Plate 25 and well beyond it, though today it is all under the plough. These vineyard-markings were associated with those of a buried trackway<sup>1</sup> bordered by a ditch on each side. The crop-markings of this trackway can be traced from the distant background to the foreground (C to D). The parallel furrows (e.g. at E) on the darker ploughed soil are entirely modern.

Plate 26, another typical example of the smaller settlements, consists of a single circular enclosure ditch with traces of at least seven 'compounds' inside it. This was photographed during the same flight as the last, when crop-markings with interestingly contrasted tones, both light and dark, were very clear. As is so often found on the Tavoliere, the site adjoins an existing farm. A narrow in-turned entrance gap, with antennae ditches projecting within, can be seen (at F).

After these descriptions, the major crop-mark features on Plate 27 should be easily apparent. The settlement is one of those in which we can identify the total number of 'compounds'. They were placed in a row,<sup>2</sup> with their backs

<sup>1</sup> Apparently connected with the great Apulian system of medieval droveways (*tratturi*) that were used by millions of sheep in annual transhumance. Many *tratturi* and field boundaries were swept away in a drastic repartition of the land under Fascism to settle tenant farmers, in a lay-out of regular blocks that superficially resembles Roman centuriation. Many details of 19th and even 20th century maps have changed beyond recognition, and for some areas the air photographs themselves form the only accurate map of the living landscape. As a result of these radical changes, we have to consider carefully the field archaeology and crop-marks even of the 18th and 19th centuries.

<sup>2</sup> Some small black dots among them may not be the crop-markings of Neolithic storage pits, but of former tree-pits for an orchard belonging to the farm.



to an entrance gap (C) in the double ditches. The entrance across the inner ditch narrows to c. 8 feet. This gap points towards the broad belt of coastal marsh and lagoon (E), the edge of which can be seen in the upper left-hand corner beyond the farm of Posta Siniscalchi (at the centre of the photograph). The site adjoins Amendola railway station 12 miles S.W. of Manfredonia, and stands on the edge of a slight natural rise along which crop-markings extend (D). Its overall dimensions, with the double ditches included, are c. 290 × 200 yards. Only 200 yards away, although not covered by this Plate, are the traces of yet another oval settlement of the same size and shape, also with two ditches. This distance seems too small to admit the explanation of 'shifting cultivation', in its normal sense. Such similarity of plan between neighbouring sites (e.g. along a well-placed escarpment) was observed a number of times during the interpretation of these photographs of the Tavoliere.

The settlement surrounded by multiple ditches (Plate 28) on level ground near Masseria Fongo, 4 miles south of Foggia, is typical of many of the larger sites, all being roughly circular or oval. Its position has no natural strength, though one flank is covered by the marshy zone round S. Lorenzo in Pantano. The central portion of the site was not showing crop-marks when this photograph was taken on 19 May 1945, but the funnel-shaped inturned entrances (at F and G) through the first and second of the four ditches could be recorded photographically even at a height of over 3 miles. Inclusive of the ditches, the overall length of the site down its longer axis (calculated from the scaled vertical view) measured c. 480 yards, or more than a quarter of a mile. The inturned ditches of one entrance (at G) were c. 70 feet long at least, and the roadway through them c. 12 feet wide. The crop-mark of the 'village' ditches averaged 12 feet across; there is a curious bulge at one corner of the innermost one (at H). The four ditches are spaced symmetrically with the intervals between them more or less constant, the total distance over which they are spread being c. 70 yards overall. All round the site (e.g. at I) are traces of Roman vine trenches, etc.

Other large circular 'villages' were seen to have four ditches surrounding them, neatly sited in pairs close together, and one remarkable settlement on an escarpment had no less than eight! The plans of a group of selected examples, drawn at a uniform scale for purposes of comparison, will be found in one of my earlier articles in *Antiquity* (June 1949, figs. 1 and 2), and it may be helpful to contrast them with those illustrated here, which are sufficiently clear to have no need of diagrams.

I shall only make a passing reference to one other site, at Passo di Corvo 8 miles N.E. of Foggia, which is too remarkable to be omitted altogether. It lies on level ground and some little distance from any stream. An oblique air photograph of this great 'village' site taken on a flight with Williams-Hunt, and a vertical for comparison, first appeared in *Antiquity* (December 1946), and have since been reproduced many times. As it was the scene of excavations in 1949-50



during the Apulia Reconnaissance its full description is reserved for that report, although interim details have appeared in *Antiquity*, June 1950. Suffice it to say, here, that the photographs by themselves provided a magnificent site plan even independently of excavation, revealing in detail a formidable settlement that wears the aspect of a tribal centre, measuring no less than 800 × 500 yards overall, with well over 100 'compounds' inside a great enclosure formed by several wide ditches;—the whole lying at one end of a larger outer 'corral' demarcated by its own ditch. All this was expressed in crop-mark form.

To complete this survey of the opening phase of the discovery it remains to mention briefly certain similar sites which proved useful for comparison.

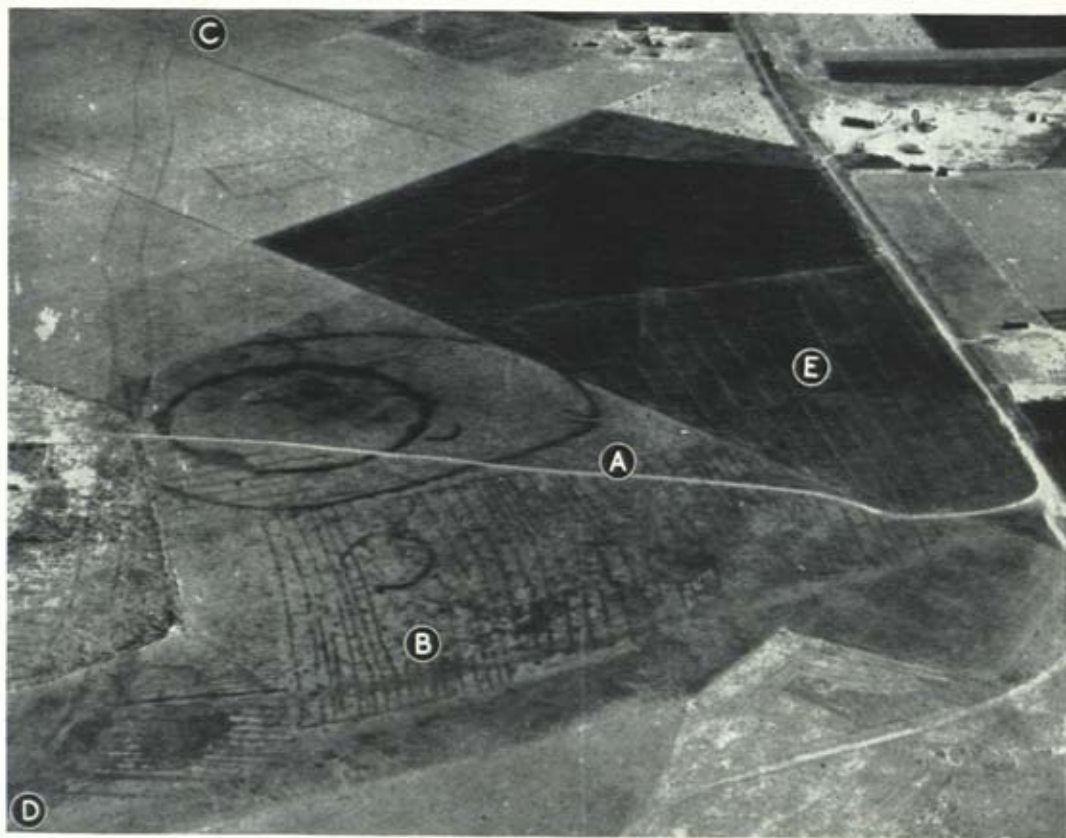
The plans of many of the smaller sites on the Tavoliere have, it was agreed from the first, a very close correspondence in form and dimensions with the handful of sites enclosed by rock-cut ditches on the limestone hills of the Murge, round Matera 80 miles to the south-east of Foggia. Some of these were tested by excavation by Ridola<sup>1</sup> and others by Rellini,<sup>2</sup> and classified by them as 'Neolitico-Enceolitico', equivalent to Neolithic-Chalcolithic. Stevenson has suggested that these ditch-enclosed settlements first appeared in the second of the three phases into which he subdivided the Neolithic. Fieldwork had, up to now, located some 8 sites of this type on the Murge:—two at Tirlecchia, one each at Murgia Timone and Murgecchia, three at Serra d'Alto, and one lesser-known one at Ponte di Palomba (largely destroyed by the Matera-Laterza road). Several other sites are known in the locality (at Tre Ponti, Setteponti, etc.) which produced the same types of Neolithic pottery, but have not yet produced evidence of ditches. Stevenson mentions that a small unpublished Neolithic site on the sea-edge at Torre a Mare, near Bari, was certainly not ditched, but the existence of open unditched sites in any significant numbers remains problematical.

Vegetation markings had, in fact, already been recognised. Thus on the Murge grass-marks indicated the ditches of Neolithic settlements in exactly the same way as on the Tavoliere. The two at Tirlecchia were first seen by a local archaeologist, Dr. Ridola, early in June 1916 from an overlooking slope. He commented that the contrast between the grass already dry and withered, and the big circular line of greener and more luxuriant grass (*più verde e più rigogliosa*), was very striking. The width of the marking was the same as that of the ditch when excavated. It was his observation of grass-marks which first showed the plans of the enclosures he found at Murgia Timone and Murgecchia. In all the sections cut through their ditches pottery was abundant, exclusively Neolithic from all the primary levels. But it is indeed probable that the existing plans of these famous sites could be improved in detail by air photography.

<sup>1</sup> *B.P.I.*, 1924, 97; 1925, 85; 1926, 134.

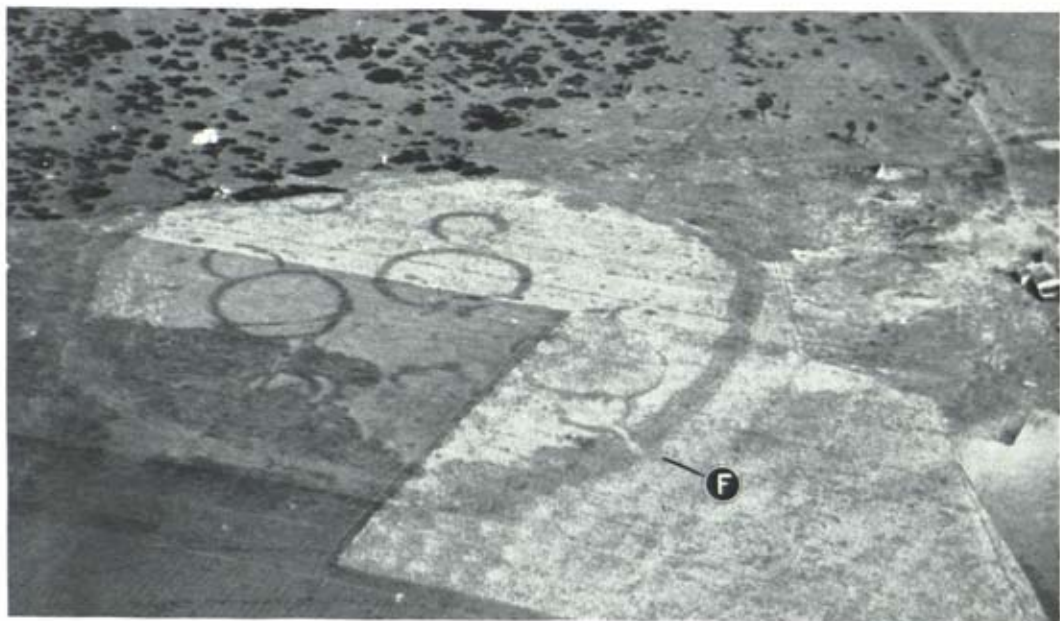
<sup>2</sup> *Notizie degli Scavi*, 1925, p. 257 seq.; and *La Più Antica Ceramica Dipinta in Italia*, 1934. For other sites of this period in southern Italy, see references in P. Laviosa Zambotti, *Le Più Antiche Culture Agricole Europee*, 1943, 18 seq.





25. SOUTH ITALY, APULIA, 8 miles north-east of Foggia. An example of one of the smaller sites of Neolithic plan discovered from the air. A total of more than 200 have been found, some being very large. This example measures *c.* 170 yards overall and was enclosed by two ditches whose buried outlines are shown by crop-marks. (A) Inturned entrance to the settlement. (B) Crop-marks in parallel lines, indicating the buried trenches of old vineyards. (C-D) An old buried trackway, probably medieval, shown by a crop-mark above the ditch on each side. (E) Non-archaeological: the white lines are the furrows of modern ploughing. See p. 99.

*Ph. Bradford, May 1945.*

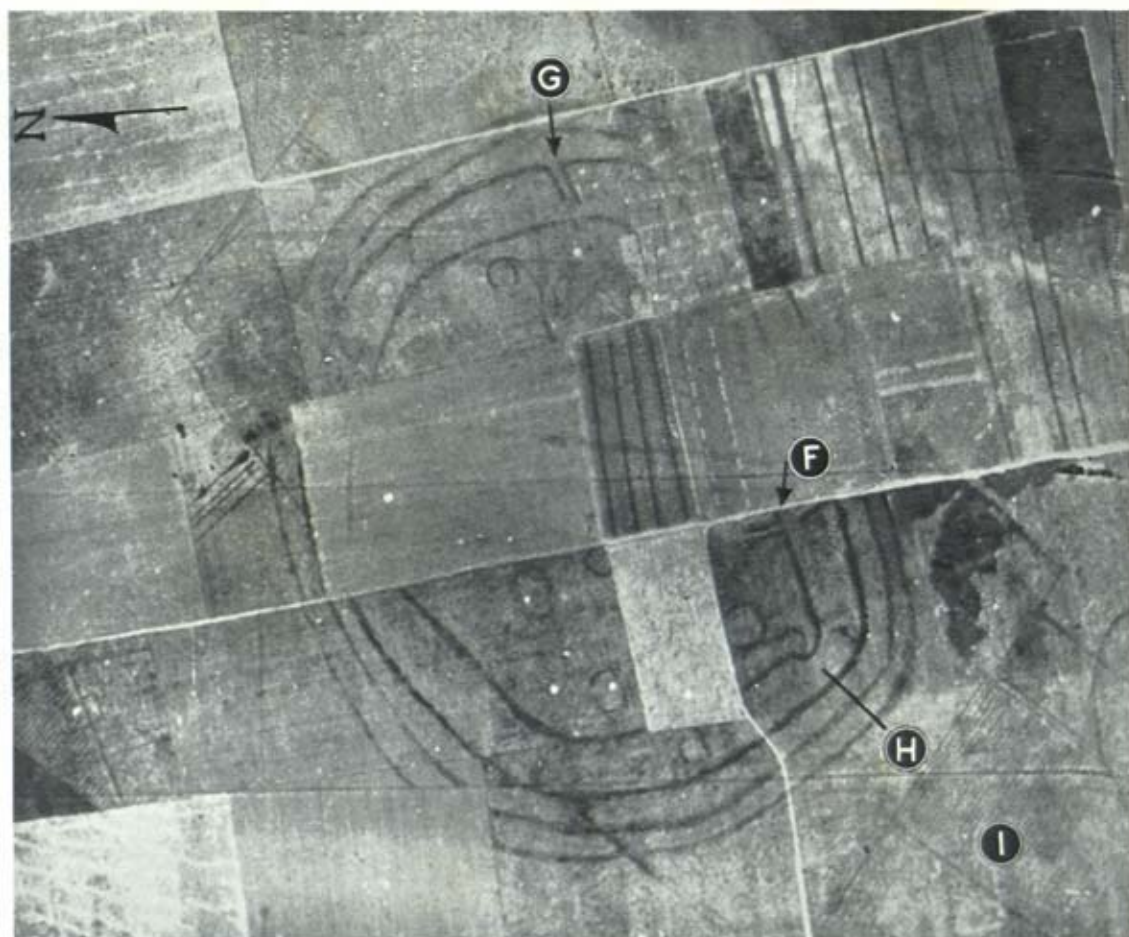


26. APULIA. A low oblique photo of a Neolithic settlement found from the air near Foggia. It is outlined by the circular crop-mark of its buried enclosure ditch, and by those of the circular 'compounds' inside it. (F) The inturned entrance to the site. See p. 100. *Ph. Bradford*, May 1945.





27. APULIA. A vertical view of an oval site of Neolithic layout found from the air by crop-marks seen above its two buried ditches (c. 290 × 200 yards overall), with 'compounds' arranged in a line along one side. The settlement lies on the edge (D) of slightly rising ground, overlooking the coastal marshes (E) formerly a lagoon. (C) The probable position of an entrance. The site adjoins Amendola station (lower right-hand corner) 12 miles south-west of Manfredonia. All other markings on the photo are caused by modern agriculture. See p. 100. *Ph. Bradford, May 1945.*



28. APULIA. A vertical photo showing a large Neolithic village discovered from the air: crop-marks showed the four buried concentric ditches surrounding it. The site is 4 miles south of Foggia, and measures *c.* 480 yards overall. (F, G) Crop-marks show two inturned entrances. (H) A bulge at the corner of the innermost ditch. (I) Crop-marks above the buried ditches of Roman property-boundaries and vine-trenches. See p. 101. *Ph. Bradford, May 1945.*



It is to Ridola's credit that even by 1924 he was urging the need for the total excavation of one settlement, and he added 'Who can say how many surprises would arise from such a future methodical excavation?' It is time to re-emphasise the decisive importance of the systematic clearance of a really large part of a single site. We have seen in recent years an example of how this policy was applied to a large part of the Iron Age farm-enclosure at Little Woodbury in Wiltshire, and the way in which it advanced our understanding of the period by a bound.

This is not the occasion to show in detail all the features which the sites on the Murge and on the Tavoliere have in common. Nor can I embark here on any discussion of the origins of these Apulian settlers, or of the overseas parallels with their settlements, which are to be considered fully in the light of the material obtained by the excavations in 1949 and 1950. The comparison with the ditch-enclosed Neolithic settlements along the east coast of Sicily is the first to suggest itself and we can see from Orsi's descriptions<sup>1</sup> that they are like ours in very many respects. No less real are certain affinities with sites in Greece and its adjoining islands. But, in order to pursue these matters further, one ought naturally to consider the full weight of the evidence from material finds,—a welcome course but outside the stated purpose of this chapter. Once excavation has opened the 'second phase' of study one should compare cultures with cultures, not merely the geometrical outlines of their settlements. The objective is not the endless examination of crop-markings, but to fit these Apulian communities well and truly into the international background of the European Neolithic, with its regional variations on a common economic theme of simple husbandry.

#### LIMITATIONS OF PHOTOGRAPHIC EVIDENCE: THE PROBLEMS ASSIGNED TO EXCAVATION

And now let us finally draw together certain threads in the argument, so that they shall not be masked by descriptive detail.

Excavation must always be the acknowledged arbiter in the study of the social and economic basis of such prehistoric communities as those in Apulia, but certain preliminary conclusions from the photographs can be suggested with reason. Before us are the pictorial plans of over 200 new sites, now available for study in a well-defined area of about the same size as the county of Wiltshire. The individual examples, though evidently spread over a fairly lengthy period, maintain a general uniformity in lay-out, and have a Neolithic-Chalcolithic context. In these unique circumstances there are unusual opportunities for

<sup>1</sup> Especially in his report on the ditch-enclosed settlement at Megara Hyblaea, north of Syracuse (*Monumenti Antichi* XXVII, 1921). For the nearby one at Stentinello (on the very edge of the sea, and partly eroded by it) see Orsi, *Bull. Paletnol. Ital.*, vol. 16, 1890, 177, and vol. 36, 1911, 66. Compare also the comments by Bernabò Brea, 'The Prehistoric Culture Sequence in Sicily', *Institute of Archaeology, London University, 6th Annual Report*, 1950, p. 17.



achieving, by intensive excavations in several successive seasons, a true understanding not of the life-history of one settlement alone but of the economy and society of an entire region in prehistory. The Tavoliere could be to archaeology what a compact tribal reserve is to anthropological study. For this *bloc* of settlements most certainly appears broadly homogeneous, with its sites forming as distinct a class in their regional context as do Iron Age hill-forts in England. However, to illustrate this chapter I have purposely chosen examples to show variety (as far as it exists) rather than uniformity. On the photographic evidence alone we can as yet say nothing positive about any evolution in settlement lay-out, in step with the phases in the Neolithic cultures of south Italy which are demonstrated by changing pottery styles.

It is inevitable that such discoveries should provoke many difficult questions, and this is no bad thing. At least, there is no lack of sites to provide replies. Among the problems that crowd into the mind, but are only to be resolved by excavation, the most pressing concern the social structure of the settlements in terms of man and beast and dwelling; next come those of closer chronology, the origin of the settlers, and the fate of these Apulian communities in subsequent prehistory in the obscure transition to the full Bronze Age.<sup>1</sup> Among other points at issue we need to know how the proportions of pastoralism<sup>2</sup> and 'garden cultivation' were balanced in the 'mixed' economy attributed to Neolithic Apulia; and also what promptings of defence (from slingstone-warfare or cattle-raiding?) induced them to draw up their lines of close-set ditches. A puzzling question, too, is the adequacy of the supply or storage of water. All these and other problems are much in mind, but here we are concerned specifically with the photographic evidence.

Flying across this great plain in early summer, with the pale greens and buffs below already bleached with sunlight and whitened with dust, it was with a feeling of admiration that I saw settlement after settlement appear for the first time in bold, clear, hard lines;—a memorial of methodical, sturdy and

<sup>1</sup> As I mentioned, in one of my first accounts, I have not been able to identify, from the air, any distinctive class of site assignable to the Bronze or Iron Age in Apulia. There is no evidence from the ditch-enclosed sites on the Murge, to the south, that their occupation was effectively continued into the Bronze Age. Personally, I think that there was a real break here. The arrival of the 'Apennine Culture' which initiates the true Bronze Age in Apulia, 'must have amounted in the first instance to an invasion', as Stevenson observes.

Since the above note was written further proof has appeared. Excavation in 1955 by Prof. Puglisi at Coppa Nevigata, on the coast of the Tavoliere, revealed a sterile layer between the Neolithic strata and those of the succeeding 'Apennine Culture'.

<sup>2</sup> If the climate was no drier than that of the present day, and if pastoralism occupied a prominent place in the local Neolithic economy, the growth of winter grass on the Tavoliere would have been adequate, and even a principal attraction to settlers. But the movement of herds to mountain pasture might have been necessary in summer; i.e. the origin of that practice of transhumance for which the region has been famous up to the present day. This would be an important point to establish; but climatic data for prehistoric Apulia are so far negligible, and there has not been sufficient systematic study of the bones of domesticated animals from early sites. There is nothing incompatible between the practice of transhumance and the existence of permanent settlements on the Tavoliere.



ingenious peasants whose labours prepared the way for the evolution of cities and nations. Here were orderly revolutionaries on the grand scale, laying a firm foundation of settled community life more than 2,000 years before Imperial Rome. It is unthinkable that the formation of the peasant character of this whole region of South Italy was not to some degree affected, far into later periods, by these centuries of earliest farming.

### NEOLITHIC SEAFARING

One matter affecting this landscape remains to be noticed. I have mentioned the simple form of 'mixed economy' (plant and animal husbandry) by which the Neolithic communities of Apulia are thought to have obtained their 'daily bread' (or perhaps 'daily milk' was of more importance). We have heard so much, and rightly, of food-producing as the germ and foundation of the 'Neolithic Revolution' that we may come to think of this vital phase as almost exclusively in the hands of landlubbers, especially when we picture the plodding advance of 'shifting cultivation' across Central Europe. But in the Mediterranean (and elsewhere) we must not omit the sea from our calculations. The air photographs show a whole string of ditch-enclosed settlements along the sea-board edge of the Tavoliere on the Gulf of Manfredonia. At the least it would indeed be surprising if these were not engaged in fishing or if Taranto's famous *zuppa di pesce* did not have its Neolithic prototype. What were the Neolithic settlers on the island of Capri if not largely fishermen? Fishing must have provided the first training for sea-faring ventures. Consider other coastlines: to stand on the site of the famous Neolithic village at Stentinello on the beach north of Syracuse, with the waves lapping its sides, is to appreciate the full force of its purely maritime position,—a reality that does not reach one through most books. Or again, to row and sail from the snug coves at the foot of the Neolithic settlement on Lipari among the islands off the Sicilian shore, is to experience the unity of sea and land in life's daily round. In such a setting, cautious sea-faring in Neolithic times is seen to be natural and inevitable. In Apulia, it follows logically that the discovery of so many new sites ashore has made it necessary to turn an enquiring eye to sea also. I suspect that, if we look for evidence, we may find that some of the inhabitants spent much of their time 'messaging about in boats'.

Such reflections are a reminder that an issue of real consequence is involved. The importance of Bronze Age trade and sea-roving in the Mediterranean emerges more clearly with every year's work. But an earlier stage will often exhibit signs of traits proper to the next period. It would now seem that we ought to lay additional emphasis on sea-going among the Neolithic cultures of this region. We can people our landscapes of coastal plains and islands with industrious Neolithic peasants, but what of the seascape? The latter has received less attention, for evidence of its rôle has only recently begun to take shape.



In writing of the eastern and central Mediterranean I have in mind not so much Neolithic trade (in which obsidian seems the only certain object of long-distance exchange) as the transmission of cultures and actual migration in this exuberant period. Archaeologically the details are still dim, but at least we shall have lowered the back-cloth to our prehistoric scene on land. Any discussion of ancient sea-faring hinges, of course, not only on existing knowledge of the extent and whereabouts of archaeological cultures but also (and almost as important) on a practical experience of boat building and handling,<sup>1</sup> and of winds and weather afloat.<sup>2</sup>

The evidence on prehistoric navigation in N.W. Europe has been reviewed in detail by Professor J. G. D. Clark, who wrote 'It is impossible not to be impressed by the ease with which stone axe blades were distributed by Neolithic traders from Ireland to Britain, or from England to the Isle of Man or the Channel Islands'.<sup>3</sup> In this period, in almost all parts of the Mediterranean there was good timber in quantity for boat-building; Cyprus and Crete, for example, were thickly wooded. But the physical conditions in this region are not usually well suited to preserving the remains of prehistoric wooden vessels (although the stagnant lagoons on the Apulian coast might prove the exception).

In the dawn of the early Bronze Age in the Aegean, representational art (notably in the Early Cycladic culture) fortunately allows us to receive crude but effective pictures of primitive ships,<sup>4</sup> 'propelled by oars but not demonstrably by sail'.<sup>5</sup> They are shown as rowing-galleys with a tall shaped prow, which would help to lessen the shock to the hull in beach-landings. But the generally geometric and non-representational basis of Neolithic ornament makes no contribution, except an artificial gap of 'negative evidence' that is sufficiently

<sup>1</sup> As the writings of James Hornell in particular have shown us.

<sup>2</sup> On these conditions, see especially Sir J. L. Myres, *Geographical History in Greek Lands*, 1953. "In many ways Aegean and indeed all Mediterranean seafarers have their lot cast in pleasant places". Among the advantages is "the bright limpidity of the water, betraying rocks, shoals and tunny alike, itself in part due to tidelessness, as well as to the predominance of pure limestone on shore". This is an important fact. It enables Mediterranean boatmen to make confident use of the innumerable rocky coves for their landings; sand is welcome but not essential.

Surface currents and winds are on the whole dependable, and helpful for two-way voyages in the eastern 'lobe'; cp. Marion Newbigin, *Southern Europe*, 1949 ed., 23 seq.

<sup>3</sup> *Prehistoric Europe: the Economic Basis*, 1952, 282.

I can only refer here to the latest clear proof of considerable Neolithic seafaring, in E. M. Jope's important paper in the *Ulster Journal of Archaeology*, 15, 1952, 31 seq. Large numbers of Neolithic axes of a distinctive stone (a porcellenite from Antrim) have been analysed petrologically (by slicing and the microscopic examination of thin sections), and we can now see from their distribution throughout Great Britain that they were freely traded across the Irish Sea. This 'opens up vistas of extensive trading in late Neolithic times throughout the British Isles which are sometimes hardly even hinted at by evidence from other sources.' The same methods should be more widely applied by prehistorians in Mediterranean lands.

<sup>4</sup> See Marinatos, 'La marine Créto-Mycénienne', in *Bull. de Correspondance Hellénique*, 1933, 170-235 and plates XII-XVII; note the Early Minoan clay model of a vessel.

<sup>5</sup> V. G. Childe, *Prehistoric Migrations in Europe*, Oslo, 1950, 61. But it would be wise to keep an open mind about the possible use of sail in Neolithic times, before the first representations of single-masted Aegean vessels early in the Early Minoan period in Crete.



daunting. However we need not add to our difficulties by inhibiting doubts about the possibility of stone-using cultures making and navigating sea-going craft to great effect. It is not suggested that Neolithic craft in Europe reached the technical heights of Maori canoes,<sup>1</sup> but these and others made by recent tribal peoples do at least serve to remind us of how much *can* be achieved with ground and polished stone adzes and chisels. Even a large, roomy dug-out canoe is not to be despised (a plank or two added to raise the sides would take one well on the way to carvel-built craft), and 'Megalithic' voyagers to the western shores of Britain may have had nothing better.

The Mediterranean gave almost ideal practice grounds for primitive navigation. There were abundant harbours and welcome sandy beaches. Numerous promontories and high islands provided landmarks to steer by and also vantage points from which to scan the sea; and the value of high reliefs would be accentuated by crystal-clear visibility at the right season,<sup>2</sup> giving a prospect of far-distant shores to lure on the essentially enterprising trait in Neolithic culture. Like other ancient mariners they doubtless took to sea during the long summer season of limpid days and starry nights. It is often urged, rather deprecatingly, that theirs was only 'creeping' navigation, hugging the shores. Today this seems ignominious, in ancient times it was not. The Athenian and Peloponnesian naval forces, when at the height of their powers at the end of the 5th century B.C., did not scorn a point to point course along the coasts.

It does not seem that Neolithic peoples only took to the sea when literally driven into it. Their wide diffusion by sea routes is sound evidence of their knowledge of how to make and handle boats. We have heard rather too much of 'boatloads of fishermen blown off their course,' and forlorn explorers left high and dry. Certainly a single boatload of determined men set down on a foreign shore can often exercise an effect out of all proportion to its numbers, under favourable circumstances. But it would be absurd to stress a 'Robinson Crusoe' element. Neolithic cultures did not spread through the Mediterranean in this manner. There must have been deliberate movements by sea, with the accompaniment of the essential domesticated animals and stores of seed grain. Neolithic settlement in Crete seems a case in point. We know of no earlier inhabitants there than these immigrant farmers. The beginnings in Crete have

<sup>1</sup> Cp. Sir Peter Buck (Te Rangi Hiroa), *The Coming of the Maori*, Wellington 1950; A. C. Haddon and James Hornell, *Canoes of Oceania*, Bishop Mus., Hawaii; 3 vols., 1936-8. The Tahiti fleet seen by Capt. Cook in 1774 numbered c. 330 canoes with an estimated 7,760 men aboard. There were specialised types of canoe, for war, sea-voyaging, and as transports, victuallers, etc. For constructional methods, see esp. vol. I, 129-35. Maori tradition states that the 'Fleet' which colonised New Zealand from Fiji in the 14th century consisted of no more than 8 war canoes.

<sup>2</sup> E. C. Semple, *Geography of the Mediterranean Region: Its Relation to Ancient History*, 1932, 579 seq., gives many good examples of the visibility of sea-marks. From Cyprus one can see Cilicia, from Rhodes even to Crete, from Sicily Pantelleria. Stromboli (in the Lipari Islands), spitting out flame every few minutes, played the part of a 'lighthouse' for sailors in Classical times. I have personally verified these impressive examples of visibility. Another aid to navigation is that the position of islands below the horizon is usually indicated by a bank of clouds above them.



been overshadowed by later periods, and we are not yet in a position to appreciate the full importance of this first, long, nascent phase. At Knossos we know at least that the ruins of successive Neolithic settlements<sup>1</sup> produced a mound over 20 feet high. We may even speculate whether further excavation will perhaps show that it was fortified, as a small proto-town somewhat on the analogy of the remarkable instance at Neolithic Jericho. Turning to the Greek mainland, Professor Childe has suggested a North Syrian rather than Anatolian origin for its first Neolithic,<sup>2</sup> and pottery parallels between Crete and Mersin in Cilicia likewise suggest some form of connection along the southern shores of Asia Minor. Among other coastwise Neolithic 'lines of communication' we may mention that down the Gulf of Corinth to the island of Levkas, then up the coast and across the straits of Otranto (by a jump of 50 miles) into Apulia. There has been a tendency, as Sir Arthur Evans once pointed out,<sup>3</sup> towards assuming that 'primitive man shrank from voyages across the open sea. The assumption is wholly ungrounded. At a very early stage in man's evolution we are encountered by the problem of his first appearance on the Australian continent, and already, by the time of the birth of the true Neolithic, considerable advance in sea-faring knowledge seems to have been attained'. He goes on to add that what was successfully ventured during this period along the Atlantic coastline, exposed to gales, 'must have been well within the capacity of the mariners of the Inland Sea. It is possible to go further than this and to affirm that the early Mediterranean seafarers preferred the open sea to the rounding of iron-bound headlands or coasting along surf-beaten shores'.

Naturally it is important not to overstress a sound point. 'It is not enough to live by the shore to become a good sailor'. Thus the provisional conclusion from the two vital islands of Cyprus and Crete is that their Neolithic peoples would go to sea if they wished but that incentives to do so only operated spasmodically. The distribution-map of Neolithic sites at present known in Cyprus<sup>4</sup> shows that many more lay inland from the coast than on it. In Crete, too, the same preponderance of inland sites has been recorded. These distributions may prove to show the correct balance, but in both islands the search has only recently developed systematically. Until the Swedish Expedition of 1927-31, the earliest civilisation in Cyprus was thought to be that of the Copper Age. But since these initial discoveries, Dr. Dikaios has been able to add as many as fifty Neolithic sites.

The importance of islands, which is a cardinal feature in Mediterranean

<sup>1</sup> The 'Harbour Town' for Minoan Knossos lay just east of Candia, and stood in relation to it much as the Piraeus to Athens. Copious remains on the coast also indicate Neolithic occupation along the sea front of this site.

<sup>2</sup> Whichever was the precise route, 'it really looks as if the first colonists in Greece had crossed the Aegean', V. G. Childe, *Prehistoric Migrations in Europe*, 47.

<sup>3</sup> 'The Early Nilotic, Libyan, and Egyptian Relations with Minoan Crete' (Huxley Memorial Lecture), *Journ. R. Anthropol. Inst.*, 1925, 201.

<sup>4</sup> See P. Dikaios, *Khirokitia*, 1953.



history thereafter, begins in this period. The islands large and small which show evidence of settlement make a long list:—Cyprus, the Dodecanese, Crete, Gavdhos, Melos, the Ionian Islands (Levkas and Ithaka), Corfu, the Tremiti, Sicily, the Lipari group (including Panarea and Salina), the Egadi, Elba, Sardinia, Malta<sup>1</sup> and others within the area mapped on Fig. 5. It sometimes happens that we have proof of the existence of maritime connections, while we are unable as yet to establish the exact form they took. A crucial instance of this is the geographical distribution round the Mediterranean of certain types of early Neolithic pottery, some plain, some with impressed ornament, particularly of the cardial type (a distinctive zig-zag pattern made with the edge of a *cardium* shell),—much used in Apulia and Sicily for example. This style is typical of the early phase of the Neolithic (although persisting into later phases), and it is noteworthy that it appears in the first stage of the Neolithic on a number of islands and coastal sites,—a point which Bernabò Brea has emphasised.<sup>2</sup> Like the present writer he would stress the view that the Neolithic is to be identified with the beginnings of effective navigation in the Mediterranean. It seems perfectly reasonable to suggest that a basic early Neolithic culture was transmitted round the Mediterranean largely by sea routes, for otherwise it would be hard to explain the way in which islands (even those of smallest size) figure prominently in its diffusion.

Emigration,—or ‘moving on’ to put it more precisely,—seems to have been the normal outlet for an expanding population having a simple Neolithic economy. And it may be suggested that migrational ‘tramping’ along the coasts was at times the equivalent of ‘shifting cultivation’ overland. The ‘transmission of culture’ would play its part as it did in the centre of Europe. Here and there Neolithic migrants would encounter an impressionable native Mesolithic population, just as in the latest phases of the Neolithic the circumstances were reversed and the impact was made by seafaring peoples of the Copper Age from the Aegean.

‘Trade’ in Neolithic hands was restricted by the self-sufficiency of the economy. Communities produced for their own needs, and one produced much the same commodities as its neighbour. But maritime barter in obsidian<sup>3</sup> from a few

<sup>1</sup> Cp. J. D. Evans, ‘The Prehistoric Culture Sequence in the Maltese Archipelago’, in *Proc. Prehist. Soc.*, 1953, 41–94. In his period I, he notes that the first colonisation of Malta was by people akin to the Neolithic culture at Stentinello in Sicily, and probably took place in the centuries just preceding 2000 B.C. For the Neolithic colonisation of the island of Hvar, on the Dalmatian coast, see G. Novak, *Prehistorijski Hvar*, Zagreb 1955.

<sup>2</sup> Childe (*loc. cit.*, 68) puts the problem thus: ‘If cardial ware do represent a culture, and this culture be not autochthonous, it can only have been diffused by sea routes and a North African origin would seem most probable’. Cp. Bernabò Brea, *Rivista di Studi Liguri*, 1950, 25–36, ‘Il Neolitico a ceramica impressa e la sua diffusione nel Mediterraneo’. The part played in this diffusion by the southern rim of the Mediterranean still lacks sufficient evidence for a sure evaluation. Results of recent fieldwork by McBurney and Hey have emphasised the importance of the sea route along the north Mediterranean, as distinct from the African land-route; cp. *Prehistory and Pleistocene Geology in Cyrenaican Libya*, 1955, 269.

<sup>3</sup> This black, volcanic, glassy mineral had a cutting edge sharper than any local stone. It is not surprising that it was much in demand for implement making. Similarly, the modern Australian aborigines prefer

famous sources is demonstrable. It is believed that the long-continued obsidian trade from the island of Melos<sup>1</sup> in the Aegean began in this period and that the Neolithic Cretan communities imported from this source and also from the island of Yali (between Nisyros and Cos). In the earliest Neolithic levels at Knossos Sir Arthur Evans found obsidian tools. Cyprus apparently obtained its obsidian from Anatolia. By the middle Neolithic the island of Lipari (off the N. coast of Sicily) was another important centre of obsidian export, as Bernabò Brea's excavations there have recently confirmed. He has suggested that distribution by sea-passage seems the most likely origin of the obsidian used for Neolithic implements found at Arene Candide on the Ligurian coast of north Italy, and that the deposits in Sardinia or Lipari may have been the source.<sup>2</sup> Frankfort made an interesting attempt to define the extent of the Melos and the Lipari zones of trade, by means of the microscopic examination of sections of obsidian from various Mediterranean sites.<sup>3</sup> Comparisons between the specimens seemed to show differences in their composition which could be used to separate these two orbits of trade. Caution is required in making such distinctions, but there is need for further careful analyses on these lines. A joint effort by pre-historians from several countries might go far towards elucidating these early adventures in sea-going which are still too shadowy an aspect of Neolithic life and times. The consequences could be far-reaching, for the Neolithic, with its remarkable blend of the static and dynamic, is a period that is still capable of springing many surprises. Once Man takes to the sea he has always been difficult to stop:

Set him a-sailing and see how he sails!

We can extract more than a grain of wisdom from the jingle.

---

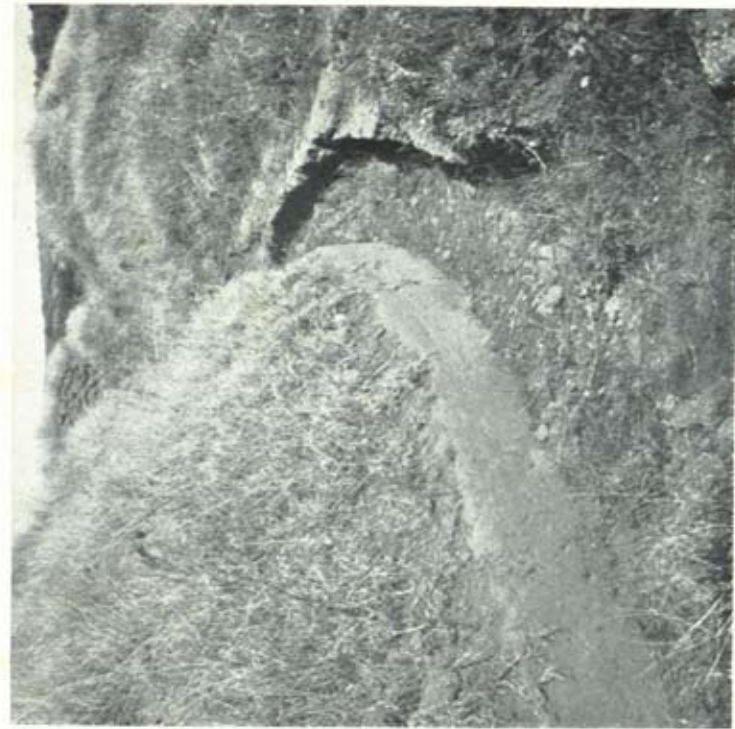
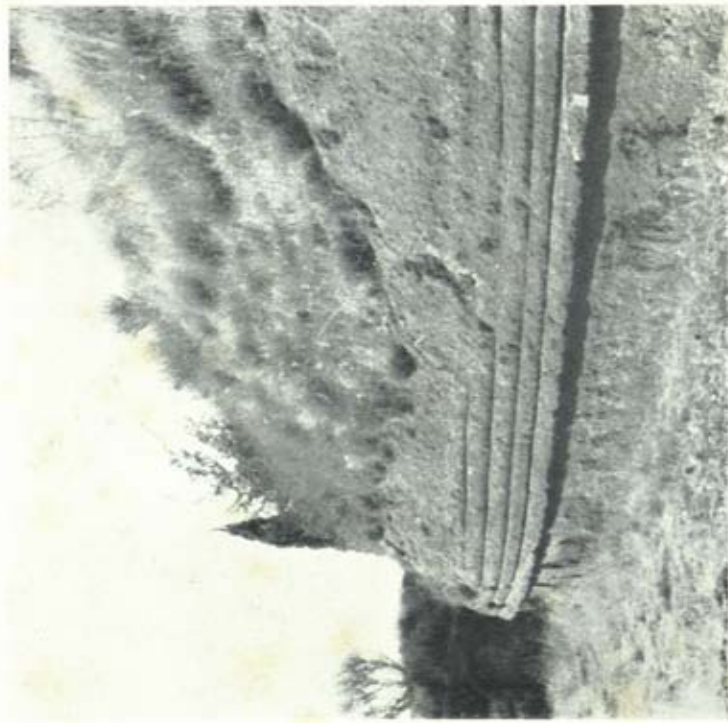
bottle-glass to chert, flint, etc., for making their fine 'pressure-flaked' knives. The porcelain insulators on telegraph poles proved such an irresistible attraction to them that the linesmen had to deposit piles of bottles as an alternative!

<sup>1</sup> See Bosanquet's chapter on 'The Obsidian Trade' in *Excavations at Phylakopi in Melos*, publ. by the Soc. for Promotion of Hellenic Studies, 1904; useful but now in need of revision.

<sup>2</sup> Riv. di Studi Liguri, 1947, 3-16. 'Commerci e industrie della Liguria Neolitica'. *Gli scavi nella caverna delle Arene Candide, scavi 1948-50*, pt. i, vol. 2, Bordighera 1956.

<sup>3</sup> H. Frankfort, *Studies in Early Pottery of the Near East* (Roy. Anthropol. Inst., Occasional Paper No. 8), 1927, pt. II, 190-2.





29. CENTRAL ITALY, CERVETERI. The profiles of two excavated Etruscan tumuli in the Banditaccia cemetery, with their mounds restored. These photos show the relation between the construction of such tumuli and the discovery of their outlines when buried. Around the foundation-drum the rock was cut away, and when the space later became filled with soil it produced a differential growth in the corn or grass above it.

(a *left*) A large tumulus excavated by Prof. Mengarelli (Fig. 8, Tum. II). The normal ground-level can be seen on the left, showing the depth of rock removed during construction. (b *right*) A small tumulus recently excavated by Prof. Pallottino, one of a group of more than seventy levelled tumuli whose outlines were found from the air at the S.W. corner of the Banditaccia (Plate 30, area R). See pp. 119 and 122. Ph. Bradford, 1953.



30. CERVETERI, 20 miles N.W. of Rome. A vertical photo of the Etruscan cemetery at Banditaccia, where over 200 levelled tumuli have been found from the air (compare Fig. 8). They were revealed by circular light-toned marks in the parched grass above their buried foundations. Such marks are the only clear indication of them. We can measure from the photos that their diameters are from 30 feet to 100 feet, and even the positions of the entrance-passages to the tombs can be seen—as a darker line on the circumference. At the centre is a zone of tumuli excavated before 1939; the site is the most famous Etruscan cemetery in Italy. See p. 121, *Crown*

*Copyright Reserved.*



### CHAPTER III

## ETRURIA FROM THE AIR

*The rôle of Air Archaeology in Etruria 111, Cerveteri, the Banditaccia Cemetery in the Past 116, The Aerial Discoveries and their Causes 119, Buried Roads and over 400 Levelled Tumuli Planned 121, Confirmation by Excavation 122, Entrances to Tumuli Visible 123, Details of Discoveries 124, Monte Abetone, a Major Cemetery 127, Plan Revealed by Air Photographs; Buried Roads and 600 Levelled Tumuli 129, Confirmed by Fieldwork 130, Tarquinia: the Monterozzi Cemetery 131, Effects of Early Exploration 132, Difficulties Inherent in Ground Survey 135, The New Aerial Plan: Location of over 800 Levelled Tumuli 136, and Buried Roads 138, Colle Pantano Cemetery; an Unusual Site 139, First Planned from Air Photos 141, Details 142, Conclusion: the Plans and Measurements Considered 143, Postscript 144: "Periscope Photography".*

### THE ROLE OF AIR ARCHAEOLOGY IN ETRURIA

THE PURPOSE of this chapter is to describe a topographical study of four cemeteries in southern Etruria. This study I began in 1944, and it has resulted in the localisation and mapping of nearly 2,000 tumuli that had been levelled to the ground and of a number of buried roads flanked by them.<sup>1</sup>

More than a century has elapsed since the now famous Regolini-Galassi tumulus-tomb at Cerveteri was opened by the Arciprete and General whose names it bears. The beautiful proportions of the silver vessels, the wealth of delicate goldwork, and the impressive design of the bronzes, which together formed the sepulchral furniture befitting an Etruscan nobleman of the middle 7th century B.C. came as a *coup d'éclat* to astonish the academic world, and can still be considered the most splendid ornament of the Museo Etrusco Gregoriano at the Vatican.

But, today, this great discovery also brings to mind the early history of field-archaeology in Etruria and the problems that have been inherited from it, of which one of the most essential still remains to haunt us; namely, the preparation of accurate plans of the cemeteries. The difficulties inherent in this are very clearly illustrated by the circumstances<sup>2</sup> of the Regolini-Galassi discovery and

<sup>1</sup> A few quotations have been made from my preliminary article which appeared in *Antiquity*, June 1947. The present account is, however, greatly expanded, with further data on all the sites, the addition of the section on the Monte Abetone cemetery, and evidence from fieldwork in Etruria in 1953 and 1956. I gave a summary in *Illustrated London News*, 16 June, 736-8.

I am glad to have this opportunity to acknowledge the friendly help received from Italian archaeologists, notably Professors Bartoccini, Mancini, and Pallottino on various occasions during the last ten years.

<sup>2</sup> According to Randall-MacIver (*Villanovans and Etruscans*, p. 195), 'no outside observer was present during the 24 hours of feverish activity which sufficed for the clearing of the tomb. No journal was kept,

by its sequel. It immediately stimulated intensive excavations for collectors' trophies at Cerveteri, where the necropolis until then had largely escaped the attentions of early antiquarians and treasure-hunters. Similar activities at Tarquinia have been characterised as 'tumultuosi' by Professor Nogara, and their story has been summed up by Professor Pallottino as 'singolare e dolorosa insieme'. Throughout the 19th century the acquisition of quantities of museum material from Etruscan sites continued with increasing fervour, and the classification of innumerable objects by typological study served to increase<sup>1</sup> immensely the knowledge of the tombs' structure and furniture. But the problems of compiling the detailed plan of any single necropolis were never squarely faced. The excavations sponsored by the State during this century, notably those of Mengarelli at Cerveteri, have at last given us some orderly plans (within the areas examined), but the chief attention has usually been concentrated on the excavation of one particular monument or limited area within a necropolis, with the result that it has remained difficult to obtain any clear idea of the general plan, or lack of it, over a whole site. And sometimes, too, there have been delays of years (as in the case of Cerveteri) before definitive publication of these diggings.

To this historic field of study we can, however, usefully summon new aid from the technique of Aerial Photography. Appropriately, it has fresh facts of permanent value to contribute to those questions where they are most needed, i.e. the number, location and siting of a large proportion of the tumulus tomb-structures within many Etruscan cemeteries. With their distribution mapped, one is also in a position to determine the course of future excavation with greater foreknowledge, and to estimate more effectively its potentialities in relation to the depredations of the past. It is by no means a simple problem. In the past, when once opened, many of the tumuli were soon forgotten, the sites unrecorded and later excavated afresh. The resulting disorder was cumulative. In fairness I should add that a properly surveyed plan of a necropolis like the Monterozzi at Tarquinia, on to which separate discoveries could be plotted, was almost beyond the powers of any private individual, except someone equipped with the resources, determination and devotion to accuracy equal to those brought to bear by General Pitt Rivers on his Cranborne Chase estates. Gallant efforts have been periodically made to condense and co-ordinate the scattered refer-

---

no observations or records were made on the spot and it is not surprising that there has been endless error and confusion'. Thanks largely to the labours of Pinza a detailed inventory of the probable original contents of the tomb was compiled, seventy years later. The definitive account of the tomb appeared in 1947: L. Pareti, *La Tomba Regolini-Galassi*. It was entered on 21 April 1836, through a hole burst open in the roof by the workmen, and the clearance of the treasure was completed next day (Pareti, 77 seq.).

<sup>1</sup> The history of Etruscan studies, to which archaeologists from so many countries have contributed, was summarised by Prof. B. Nogara in *Gli Etruschi e la loro Civiltà* (1933), and 'Gli studi etruschi negli ultimo cento anni' in *Bull. Università Italiana per Stranieri di Perugia*, 1939, 3-31; and also by Prof. Pallottino in his survey entitled *Etruscologia* (3rd ed. revised, 1955).



ences to casual exploration in the past with which the literature teems and much of the confusion about the location and construction of individual tombs has been cleared up by *literary* spade-work rather than by field-work. At the end of the 19th century Pasqui did what he could for Tarquinia, and no praise can be too high for such painstaking and monumental research and synthesis as that devoted by Professor Pallottino to this site.<sup>1</sup> Reconstruction from written sources, however, is naturally made difficult by the inherent incompleteness and inadequate presentation of the original material which it sifts, and by the inexact observation on which these accounts were only too often based.

To the best of my knowledge, no series of air photographs of an Etruscan necropolis had been published and interpreted in detail prior to those in my article in 1947,<sup>2</sup> although verticals and obliques were taken round Cerveteri by an Italian aircraft in 1935 (see below, p. 126). The authorities at the Museo di Villa Giulia in Rome have twice kindly allowed me to examine these. Judging by practical experience, elsewhere,<sup>3</sup> it seemed clear that Etruscan cemeteries should lend themselves especially well to the employment of this technique, by reason of the kind of structures they contain. This inference was fully confirmed during the war by photographs taken by the R.A.F., although flying conditions were naturally not exactly those which would be chosen for the best archaeological results! But the skill of the pilots and the excellence of the cameras were such that, in fact, large numbers of valuable archaeological discoveries were made from photographs taken under conditions of altitude,<sup>4</sup> etc., that would have been considered out of the question for this purpose before the war. Fortunately, the requirements of research asserted themselves sufficiently at the time to prompt me to take note of the most informative air-photos of the major Etruscan sites,—and examples from Cerveteri and Tarquinia, as well as another and almost unknown necropolis, have been selected for illustration.

The results point the way to the future policy for Etruria, which should be to

<sup>1</sup> In his monograph in *Monumenti Antichi* (Accademia dei Lincei), vol. 36.

<sup>2</sup> An air photo of one cemetery had been published by Antonio Minto, *Populonia* (Ist. di Studi Etruschi, 1943), but quarrying on the site prevented the discovery of tumuli by this means.

<sup>3</sup> I.e. proceeding from the ascertained principles of cause and effect that produce soil-mark and crop-marks, which were tested and shown to be valid on a variety of soils in England. Italian archaeologists, notably Professor Lugli, had appreciated that the results obtained by Crawford and Poidebard, under very different circumstances, had a general application within a wide range of terrain and vegetation conditions. See Lugli, 'L'importanza del rilievo aereo negli studi di topografia archeologica', in *Atti del V Congresso Nazionale di Studi Romani*; and also *Saggi di esplorazione archeologica a mezzo della fotografia aerea*, 1939.

<sup>4</sup> In the clear weather that prevails for much of the year in Italy, crop-marks can be photographed from heights of 2 or 3 miles (10,000-15,000 feet) with excellent results when modern 20- or 36-inch focal-length air-cameras are used. There is little doubt that in other parts of Europe, too, archaeological air photography for some of the indispensable *verticals* might well be done at higher altitudes than those used before 1939, especially over little-known areas. The increase in the amount of ground thus covered by each photograph is a big economy (see facts listed on p. 58), and the results give photographs of a scale quite large enough for detailed interpretation with a view to excavation. The discoveries in Apulia are a case in point. There are big gaps in European distribution maps, some of which could be filled by 'search' flights in this way. Low verticals and obliques could then follow, as required.



plan and complete a programme of systematic air-photography, at the correct season, height, etc., to exploit the immense potentialities revealed. A preliminary aerial survey of the kind that I have suggested (to include verticals and obliques of a selection of the chief known sites, besides others that would be found while photography was in progress), might be completed in a few weeks if properly planned in advance, for economy of effort would be ensured by the experience already gained.<sup>1</sup> Until the problem of mapping the cemeteries is resolutely met and conquered, our knowledge of this cardinal aspect of Etruscology must remain inaccurate. Meanwhile, unnecessary damage and destruction by modern agriculture are certain to overtake many tumuli because they are not obvious at ground level. Indeed, in 1953 I studied an instance of such damage, involving one of the sites to be described in this chapter (see p. 141).

An essential requirement is to look with new eyes at the long-familiar field-monuments of Etruria, to see the ways in which their manner of construction renders them aerially visible, even when they lie buried. For this reason I have included a series of ground photographs, specially taken to demonstrate how the causes of aerial discovery lie in the ground and to emphasise the need for the closest attention to the surface remains.

We shall see that the air-photographs of these sites have a triple function:—(1) to discover new tombs<sup>2</sup> and to aid the re-identification of those uncertainly located, (2) to trace the course of the formal tomb-lined roads which threaded their way like streets through a necropolis to link its various parts, (3) to show in plan form, to a known scale, the picture of the tomb-distribution as a whole. The last is most valuable, because no complete plans have been published for these cemeteries. It will be remembered that an exact scale can be calculated for a vertical air photograph as for a map, and, working directly from the photograph, measurements correct within a few feet are normal after some experience with a good micrometer scale, and when the definition of the object permits such accuracy (the 'spreading' of the mounds of ploughed-down tumuli is one obvious difficulty). Under suitably favourable circumstances, a measured plan of the largest necropolis can be obtained rapidly from air photos, to include the positions of those tumuli which have been levelled and are now sometimes almost imperceptible at ground-level. They can be revealed either (i) by localised parching in crops or grass, causing circular light-toned patches above them

<sup>1</sup> See postscript, p. 144. Deep-drilling and periscope photography in 1955-6 have confirmed my air photo interpretation; see detailed reports by C. M. Lerici, E. Carabelli and E. Segre in *Quaderni di Geofisica Applicata* (Politecnico di Milano), 1956.

<sup>2</sup> I.e. tumuli and those forms of *tombe a camera* that are nearly free-standing. Further, Mengarelli (*Studi Etruschi*, Vol. I, 1927, p. 148) stated that the primitive *tombe a fossa* and *pozzetti* burials at Cerveteri had a distinctive stony filling, and so under favourable conditions they also might, in a group, give a collective soil-mark. Ground photographs of the excavations (*op. cit.*, Tav. XII, XIII, XVII) suggest that the increased depth of soil over a wide area which results from their concentration in large numbers could also produce a crop-mark; such a zone might appear as a large irregular patch differing from the surrounding vegetation. Normally we may leave it to ordinary fieldwork to record the entrances to the numerous rock-cut tombs in cliff faces.



(Plates 30, 31, Cerveteri), or (ii) as soil-marks, i.e. abnormalities in the composition of the top-soil, due (in the instance of tumuli) to the increase in the proportion of stony rubble from the ploughed-out mound in comparison with the ordinary ground all round; in such cases the tumuli appear photographically as prominent points of high-light, of varying size but roughly circular (e.g. Plate 36, Tarquinia, and Plate 33, Colle Pantano). These plates will demonstrate the rich potentialities latent in expert aerial photography of such sites,<sup>1</sup> always provided that the interpretation of the evidence which they provide is also of a high scientific standard.

I have found that the examination of stereoscopic pairs of vertical air-photographs is of the greatest value in the identification of ploughed-out tumuli, whose almost levelled mounds, often 'raise themselves up' just perceptibly when seen under the stereoscope, thus giving the effect of a visual model in three dimensions. We have seen (p. 59) that the fundamental importance of this method of examination lies in its vivid presentation to the eye of the earth's surface in correct relief; thereby developing in the mind an abnormally acute 'feeling' for terrain, until every fold and gradation of surface count towards building up the character of a site. Electrical-resistivity surveying is another valuable aid in establishing the outlines of buried tumuli.<sup>2</sup>

The chosen illustrations, which show highly complex sites in some detail, remind us of the rapid increase in the availability of air photographs which has taken place in recent years. They have of course ceased to be regarded in Archaeology as an experiment, but there is now a possible danger that their wider use may cause the interpretation of their evidence to be undertaken too casually. They necessarily suffer some loss of clarity in reproduction, and as any discussion of debatable points should take place over the original prints which may not be easily obtained, this gives a particular importance to the first interpretation. In future increasing numbers of students will be handling them for the first time, and it is important to remember that air photographs are technical documents, and deserve to be treated with the consideration due to a new form of public record,—one that demands the observation of the canons of accuracy proper to its study.

<sup>1</sup> And also for the study of sites that were once Etruscan towns. The examination of British air photos has shown, for example, the traces of the many ancient buried roads which radiate from the site of Vulci in all directions. These were not previously known, and are difficult to see on the ground, as was noted when they were ground-checked during my visits in 1954 and 1956. I shall publish a map of them shortly. See also Plate 14 for an ancient road to Veii.

<sup>2</sup> For an account of the successful use of this method at Cerveteri and at Fabriano near Ancona, see E. Carabelli, 'Ricerche Geofisiche Sperimentali su Antiche Necropoli', *Rivista di Geofisica Applicata*, fasc. 1-2, 1955 (publ. by the Fondazione Ing. C. M. Lericci); see also Ing. C. M. Lericci, in 'La scienza al servizio dell'archeologia', *La Ricerca Scientifica*, April 1956, 1043-75.

## CERVETERI

(i) *The Banditaccia Cemetery*

The great and ancient city of Caere<sup>1</sup> lay roughly 20 miles N.W. of Rome, on the forward edge of the bare angular downs looking out across the coastal plain of the Maremma to the wide horizon of the sea only 3 miles off.

One of the foremost cities of the Etruscans and as large as Veii, it occupied a flat-topped, steep-sided ridge of tufa which covered about 375 acres. By Imperial times its fortunes were well on the wane and, though never abandoned, it shrank and dwindled into the present small medieval and modern village. Dennis, whose volumes are always a pleasure to read, had an acute feeling for the topography of Caere, and well evokes that 'spirit of place' which is so necessary in archaeology. In all periods the traveller's eye would have sensed the natural dignity of the setting, 'either on the site of the city itself, with its wide-sweeping prospect of plain and sea on the one hand, and of the dark many-peaked hills on the other, or in the ravines around, where one meets with combinations of rock and wood, such as for form and colour are rarely surpassed. The cliffs of the city, here rising boldly at one spring from the slope, there broken away into many angular forms, with huge masses of rock scattered at their feet, are naturally of the liveliest red that tufa can assume, yet are brightened still further by encrusting lichens into the warmest orange or amber, or are gilt with the most brilliant yellow,—thrown out more prominently by an occasional sombering of grey, while the dark ilex or oak feathers and crests the whole'. Though stripped of its buildings the city plateau still conveys an impression of gaunt strength through its own bold natural lines.

It is estimated that the great cemeteries which completely surrounded the city on all sides covered more than 1,000 acres (not counting outlying tumuli), a necropolis scarcely equalled in extent in the Etruscan period in Italy. It is the best known of these cemeteries, that called Banditaccia, with which we shall first be concerned. Its position is shown on Fig. 6. The site is a long narrow plateau similar to, and parallel with, that occupied by the ancient city, and is highly complex structurally, with uninterrupted use from 8th century B.C. burials of the Italian Iron Age and up to the 2nd or 3rd century A.D.; in all a period of no less than 1,000 years. A century ago, according to Mrs. Hamilton Gray,<sup>2</sup> this tableland was 'full of caverns and burrowed with holes', and Dennis<sup>3</sup> called it 'a singular place;—a Brobdingnag warren studded with mole hills'. Both

<sup>1</sup> For its ancient names of *Agylla* and *Caere*, see Pareti, *op. cit.*, 40 seq.

<sup>2</sup> *Tour to the Sepulchres of Etruria in 1839*. She took as her target 'Intelligent Englishmen . . . who drewled out that perhaps upon the whole they (the sites) were worth visiting'. 'I write for the ignorant and pleasure-loving traveller, and not for the learned and antiquarian'. This is not the language of the Grand Tour of the preceding century but of the educated middle-class beginning to travel from curiosity. Her archaeological chronology was that of her day, but her personal observations, e.g. on contemporary methods and standards of excavation, are interesting because objective.

<sup>3</sup> George Dennis, *Cities and Cemeteries of Etruria*, 2nd ed., 1878, vol. 1, 238.



observers were struck by the great wanton damage to the site that proceeded under their eyes, which to the former made it appear as if 'sacked by plundering banditti'. This was largely caused by the continual depredations of peasants, busily quarrying the tumuli for blocks of dressed stone or anything that was

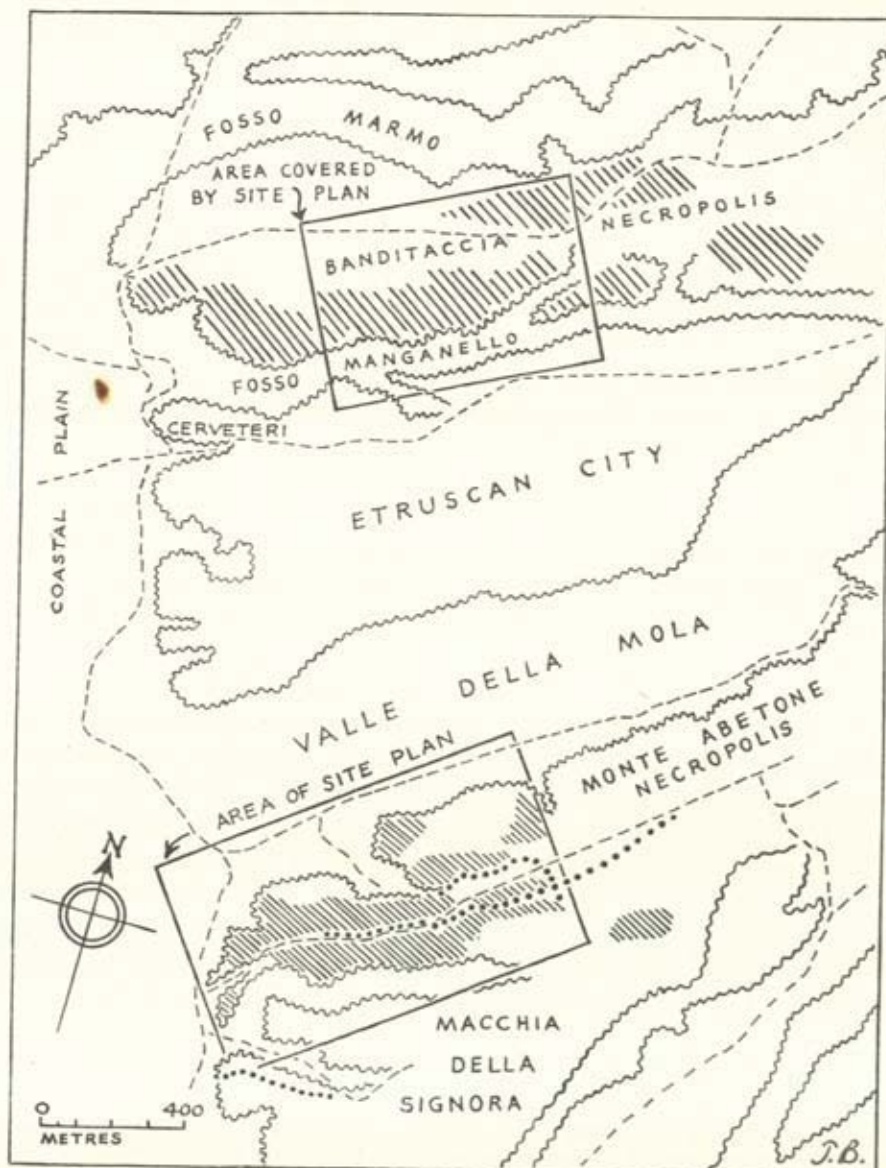


FIG. 6 Map showing the site of Etruscan Cerveteri (20 miles N.W. of Rome) in relation to the cemeteries planned on Figs. 8 and 9. Zones of levelled tumuli found from the air are shown by diagonal shading; buried roads on Monte Abetone are marked by dotted lines. Zig-zag lines indicate steep slopes.

portable. In the 19th century it was accompanied by much anarchic and haphazard excavation, which makes sad reading. On the city site, 'the very ruins of Caere have perished', wrote Dennis;<sup>1</sup> and in addition, 'the streets and buildings of a city among the most renowned of ancient times, and thirty times more extensive than the miserable village which has retained its name'. Today, the intensive cultivation of vines and olives, which covers virtually the whole area of the city, severely limits the possibilities of discovering its buildings by air photography.

If I have emphasised the past damage to the immense cemeteries round Cerveteri, it is because I believe that by the medium of air photography we can do much to remedy the situation, by contributing to those detailed plans of the cemeteries and their structures (most of them still below ground) which are urgently needed by archeologists inside and outside Italy. It has been a matter of concern that there was not a truly satisfactory *published* plan of the Banditaccia necropolis<sup>2</sup> as a whole. Indeed it sometimes proves impossible to ascertain, from the published sources, whether a cemetery road (*via sepolcrale*) which the air photographs reveal is already known or not. For individual tumuli, except for the best-known, the position has been still more difficult.

It was not until 1911 that the first methodical excavations were begun at Cerveteri, sponsored by the Italian Government and entrusted to Professor Mengarelli, who laboured for 25 consecutive years on the site of the city and in the surrounding cemeteries of Sorbo, Pozzolana and Banditaccia. In spite of this, so great are the areas involved that on the Banditaccia itself only a relatively limited zone has been subjected to systematic investigation as yet. But there is no doubt of the immensely impressive appearance of the rows of tumuli that have been cleared along a part of the principal road through this city of the dead;—the measured tread of academic prose scarcely conveys the force of their impact on the mind and eye. Strangely enough, it is for entirely contrasted reasons that a strongly dramatic effect has also been created recently by the neighbouring area which overlooks the Manganello valley, though there is little enough to be seen on the surface! For here, in this zone, we can now see clearly (on air photographs) the outline of a considerable number of important tumuli, whose mounds have been totally levelled by ploughing which continues over the whole of this part of the necropolis.

<sup>1</sup> *Op. cit.*, 236; he was 'an indignant witness' of the destruction of part of the ancient city wall, along the edge of the plateau. It is hardly surprising that he considered that 'most travellers will find it sufficient to lionise the site in a day's excursion from Palo'.

<sup>2</sup> There is a diagrammatic sketch-map of the Banditaccia on the cover of the Cerveteri booklet (1939) in the *Itinerari dei Musei e Monumenti d'Italia* prepared by Prof. Pallottino. For Caere and its neighbourhood we have, for example, a generalised small-scale map by Prof. Mengarelli (*Studi Etruschi*, XI, 1937, Tav. V) at 1 : 60,000 (roughly 1 inch: 1 mile) which shows the suggested limits of the Caere cemeteries by shading but is not intended to be a detailed plan. However, in the Museo di Villa Giulia at Rome (the seat of the *Sovrintendenza alle Antichità* for Southern Etruria) there is a valuable large-scale plan of the Banditaccia cemetery. A full publication of the excavated areas (with plans) has been in preparation by this department, and will occupy successive volumes.



The major discoveries from my study of these air photographs are:—

(i) The certain identification of the position of over 400 levelled tumuli on the Banditaccia which have not appeared on any previously published plan. The majority were entirely unknown.

(ii) The location of the exact course of several important cemetery roads and branches from them, flanked by some of the tumuli mentioned under (i).

In 1945, 1947 and again in 1953, I went over the ground carefully on foot, with the air photographs in hand, to confirm these new facts.

A ground photograph on Plate 29a shows the side of the biggest of the tumuli excavated and restored by Mengarelli on the Banditaccia. The outward construction of the tumuli explains the reason for the clear outline on air photographs of those that still lie buried. The foundation from which they rise is a solid, free-standing, circular drum hewn clear out of the natural rock (tufa)

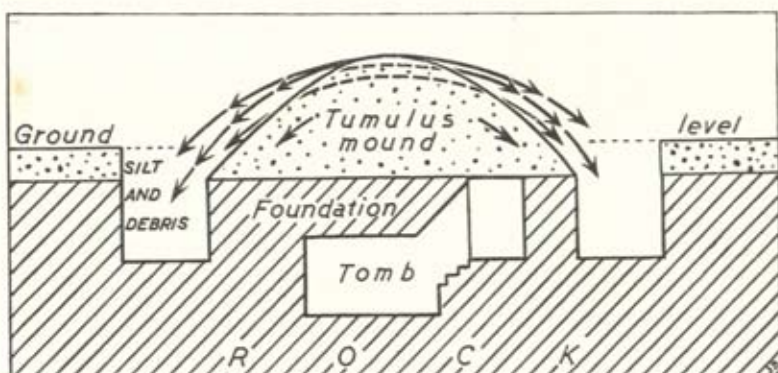


FIG. 7 Diagrammatic section through a levelled Etruscan tumulus-mound, to show the zone of deeper soil round the foundation, producing differential growth in the vegetation on the surface and assisting aerial discovery. Compare Plates 29 and 35b.

to a height of several feet. The undisturbed tufa from which this particular example was cut can be seen on the left of the photograph. In the finest tumuli the base was ornamented with carved architectural mouldings cut from the solid rock; in many others, oblong blocks of tufa were added round the edge to increase its height. On this drum the excavated rock-débris was piled at the angle of rest to form a conical mound. When this mound is levelled, as it has been above all those now revealed from the air on the Banditaccia, the buried edge of the drum's circumference can generally be located, producing a circular marking in the crop or grass on the ground above the position. The vegetation ripens or withers quickly in the shallow soil, and on the photographs this gives a light-toned marking, which contrasts with a darker tone all round the tumulus. The deeper soil, in the surrounding belt from which the tufa had been originally dug away, naturally supports a richer vegetation of a darker hue. The contrast, both from the air and on the ground, is often well-defined and we have ample

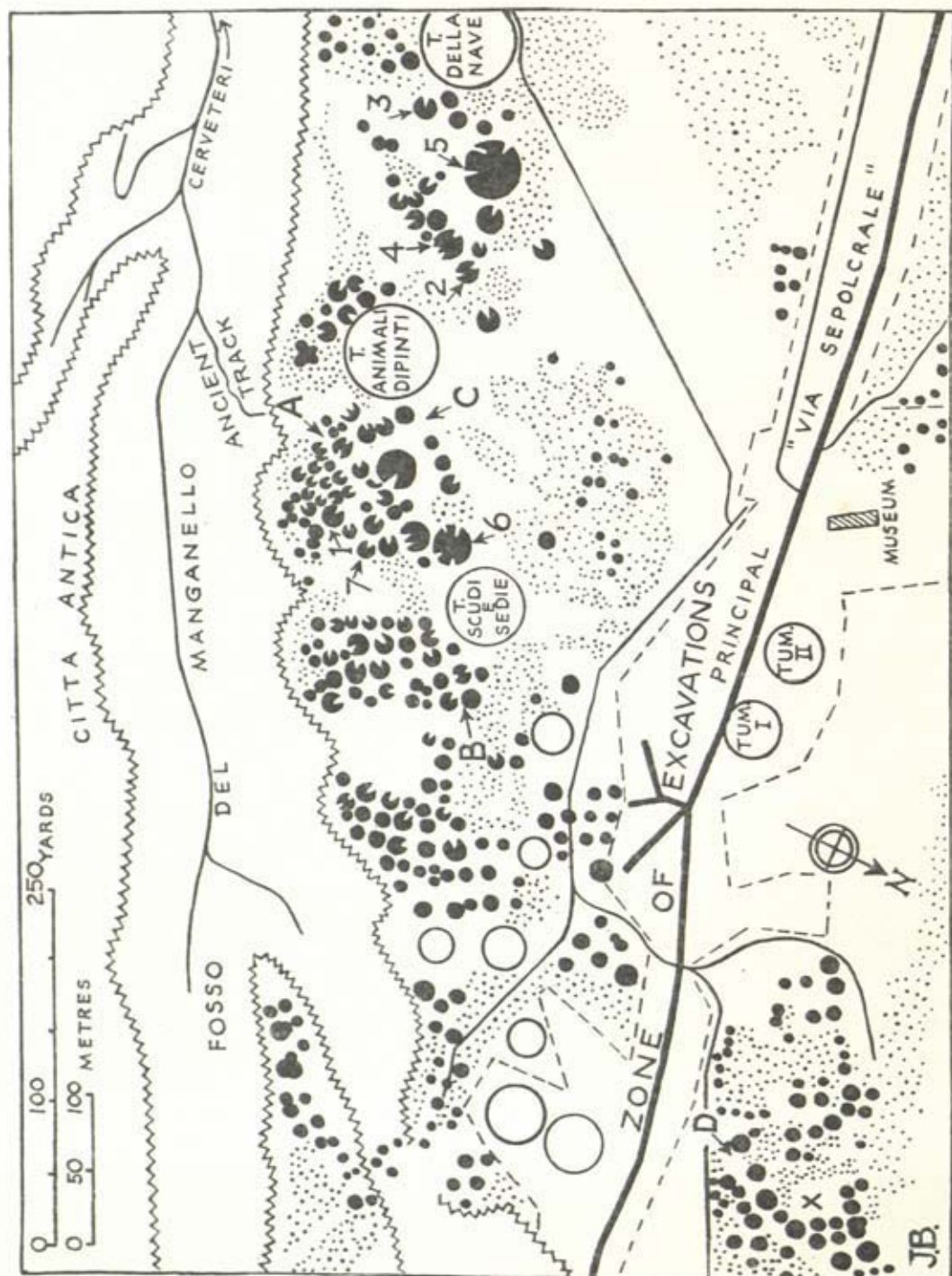


FIG. 8 Banditaccia (Cerveteri). Map of 200 Etruscan tumuli, etc., located from the air by crop-marks and grass-marks in the central part of the cemetery.

(For Key see opposite)



evidence that measurements made from good vegetation-markings will accurately record the diameters of buried tumuli. Further explanation is shown by Fig. 7.

These discoveries were revealed by vertical photographs taken on 14 May 1944, having a scale of 1 : 8,200; earlier, on 9 March, the same features were visible from the air but much less clearly. The tumuli here appear as small circular, light-toned, markings in a crop of corn; being most sharply defined along both edges of the plateau where the soil is thinner and the effects of parching on the crop are consequently more pronounced. The newly-mapped cemetery roads, originally cut down into the rock, are disclosed for the reverse reason; the silted soil, by which they have been entirely filled up, provides an additional depth of humus and conserves extra moisture and nourishment for the vegetation on top, which is consequently greener by comparison and is photographically darker in tone.

One of these buried roads (Plate 30, centre, and Fig. 8, centre), is strikingly apparent from the air;<sup>1</sup> it can be traced for as much as 220 yards between A and B, and has a short branch at right angles (A-C) which is *c.* 65 yards long. Its course is an important discovery, for its traces on the ground are almost invisible. Elsewhere in the necropolis the exact positions of other silted-up cemetery roads are shown by the photographs, outlined by parallel borders of levelled tumuli. A good example has been indicated at D, near the lower left-hand corner of Plate 30 and Fig. 8, branching from the principal ancient road through the cemetery. Its course makes a really interesting addition to the plan of the Banditaccia, as was evident when I examined it carefully in 1953. To the observer at ground level it is only just traceable as a slightly sunken line, but it is extremely clear on the air photograph for 140 yards (for the reasons given above). The original width was probably similar to that of the secondary roads in the excavated zone, and a smaller road (or 'lane') joined it at right angles. On the air photographs the alignment of tumuli along each side make these facts clear. On the ground (as seen in September) not one of these tumuli

<sup>1</sup> It broadens towards the edge of the escarpment to a width varying between 12 and 25 feet (measured from the photographs). At this point it descended to the Fosso del Manganello, and would have climbed to the 'city' opposite by an ancient road up a prominent cleft in the escarpment.

- Buried tumulus-foundation. The position of the buried entrance is also indicated (thus ^) when the crop-marks show definite or possible traces
- Well-preserved tumuli, as landmarks
- ⋮ Zones in which fainter traces of many levelled tumuli are visible from the air
- Chief excavated Etruscan roads      - - - - Limit of excavations
- Tracks and paths (1945)      ~~~~~ Edge of slope
- A B Example of a buried Etruscan cemetery road found from the air

For other letters and numbers, p. 121 seq. See Plates 29-32a.

would have been thought to exist!<sup>1</sup> Extending from this area to the far-away eastern end of the Banditaccia it is all bare, grassy downland,—without any of the vineyards and fruit trees which have been allowed to do so much harm in other parts. I have abundant evidence that there is a highly important continuation of the necropolis in this direction, and it is ideal terrain for crop-marks and air photography.

Besides these ancient buried roads, other characteristic features of Etruscan planning which can be discovered from the air are the silted-up *piazzette*, i.e. those large, oblong, sunken courtyards, made by clearing the soft rock to a depth of several yards, with tombs and their facades methodically cut out of each side, arranged in the manner of houses round a small square or *piazza*. A good example is clearly revealed at X (Plate 30, lower left-hand corner). On the ground there is only a large irregular depression with sloping grassy sides, but on the air photograph its true regular outlines (though underground) are well defined as a 'grass-marking', which allows us to distinguish the straight-cut tufa edge from the deep silt that fills this *piazzetta*.

But it is, of course, the large number of un-recorded tumuli, whose mounds have been levelled, which forms the biggest addition to the plan. I shall now turn to these, beginning at the south-west corner of the Banditaccia cemetery, i.e. the edge of the plateau at the point fronting the modern town on the other side of the narrow Manganello valley. In an earlier account<sup>2</sup> I included an air photograph which revealed an important and compact group of at least 70 small buried tumuli at this point, visible as crop-markings. The area is marked 'R' on Plate 30. The mounds of all have been levelled by cultivation, for this area is under plough. An interesting detail of the discovery was that alignments of tumuli were clear, including rows of 7 and 9 in a straight line at right angles to the edge of the plateau. Working from ground indications alone, Professor Pallottino had previously reported the existence of only 'sepolcri sparsi' in this zone; this is easily explicable, as the surface remains are very slight.

At this south-west corner, in the zone containing the Tomba della Ripa, there has been an important sequel to my discoveries in this area. On visiting this part of the site in 1953 I noted that trial excavations had confirmed some of the buried tumuli which I identified from the air photographs and published in 1947. During three weeks in May 1951 an Italian excavation (to train students of the Istituto di Archeologia of Rome University) had un-earthed over a dozen circular tumuli and a number of separate burials. Plate 29b shows one of the tumuli after excavation. Professor Pallottino was in charge of the work, and recently has supplied me with some particulars of the results. The tumuli are of the normal smaller type; they have been assigned to the first half of the 6th century B.C. Steps descend to a central tomb-chamber, usually containing

<sup>1</sup> There is a short branch road next to road D, westward, but this is obvious on the ground as a well-marked grassy hollow leading to an open space marking the site of a 'piazzetta'.

<sup>2</sup> See *Antiquity*, June 1947, plate I (group R) and p. 79.



a pair of couches cut from the living rock (tufa). As usual the tombs had been robbed in ancient times, but some of them were still rich in finds, partly *in situ*. This confirmed my earlier forecast of the useful results to be expected from the excavation of these levelled tumuli. They proved of interest not only for their architectural details, but also for the imported Greek pottery<sup>1</sup> found among the tomb-goods. It is noteworthy that several quadrangular burial structures were also found.

When we were examining these tumuli in September 1953, we observed that there was ordinarily not more than 6 inches of surface soil above the tufa here! The ground is rough pasture, and it is not surprising that clear grass-marks of tumulus-outlines were visible from the air.

Each tumulus had an architectural 'drum' or base, cut out from the solid tufa but not ornamented. The surrounding tufa had been cut away, to leave it free-standing. The base stood about 2 feet high and its diameter, measured from several excavated examples, ranged from 33 to 35 feet. It was gratifying to note that this measurement was exactly the same as that which I had calculated from the air photographs, when these tumuli were still buried. They lay very close together, sometimes with only 2 feet clear between their sides, sometimes separated by irregular belts of unexcavated tufa.<sup>2</sup>

The mounds above these tumuli have now been restored to their original height, and the interesting excavation has been concluded. It was useful for training purposes and for the further evidence it gave for the date of such tumuli. But a greater value lay in the fact that this excavation supplied the conclusive confirmation needed for the aerial identification, previously made, of over 70 tumuli in this area. Further, this was *ipso facto* confirmation of the discovery of the hundreds of others which are revealed by markings of the same kind in adjacent parts of the Banditaccia (Plate 30).

The whole strip of crop-markings along this south side of the plateau contained c. 300 levelled tumuli of various sizes that could be identified with certainty on the original photograph, besides a number of others that were less clear. They are noticeably more clear on the tops of the small rounded spurs that project into the Manganello valley than in the hollows between them, into which much soil has silted. Careful measurements from the photographs gave diameters of between 20 and 50 feet for the great majority of these tumuli, with most of them nearer the larger figure.

One of the most important aspects of these discoveries is that the passage-entrance to the buried tumuli is also visible in so many cases. The entrance has the appearance on the air photographs of a short, dark marking in the side of the circle—produced, of course, by the considerable depth of soil that has filled

<sup>1</sup> 'Notevole un pezzo con iscrizione greca arcaica incisa.' A preliminary notice of the work appeared in *Archeologia Classica*, vol. III, fasc. II, 1951, 211-2. Definitive publication is planned for *Notizie degli Scavi*.

<sup>2</sup> It is interesting to note that similar, irregular-shaped areas of tufa can be identified farther along the plateau, between the buried tumuli and planned from the parch-markings above them; see Plate 31a.



the passage and now promotes extra growth in the vegetation (crops or grass) above it. The ground photographs on Plate 29, of excavated examples, should make the explanation clear. On my site-plan (Fig. 8) I have indicated the positions of the buried entrances into the heart of the levelled tumuli whenever they could be identified from the air with reasonable certainty. A number of tumuli can be seen to possess several of these passage-entrances to tombs; and Professor Mengarelli observed, during his excavations, that such a group of tombs in one tumulus was normally spread over a generation or two.

It is very disturbing to record that in the last few years large areas of arable at the centre of the Banditaccia have been given over to intensive vine and fruit-tree cultivation. This has particularly affected the zone round, and between, the Tum. della Nave and the Tum. Animali Dipinti (see plan, Fig. 8), which was full of the crop-markings of buried tumuli when my air photographs were taken. In consequence, these tumuli are now becoming impossible to locate on the ground and all future excavation will be gravely impeded. In 1953, for example, the change of cultivation had already made it impossible to trace the positions of tumuli Nos. 3 and 4 on Fig. 8, which formerly could be found and measured every year as long as the land was under corn or grass. It would be disastrous if vines and fruit trees were allowed to spread any further over this site or other famous cemeteries of Etruria, for it must be emphasised that the tombs below the tumuli whose surface mounds have been levelled are as important as the battered remains of the tumuli that survive above ground;—and equally deserve preservation. Aerial photography, if properly carried out, soon shows which areas should be protected and kept free from trees and vines (and also from the 'deep-ploughing' into the subsoil which today is the preliminary to planting them).

The unfortunate results that follow such forms of cultivation can be seen when Plate 30 (1944) is compared with an air photo taken about two years ago for the Sovrintendenza alle Antichità of Southern Etruria and published in an important booklet *Prospezioni Archeologiche* (1954) by Ing. C. M. Lerici (Tav. X). This latter photo was taken on infra-red sensitive film, but the buried tumuli could not be clearly seen, as they had been before this part of the cemetery was carved up into little fields, vineyards and orchards. The buried tumuli, we must note with regret, cannot ever again appear as well defined as on the photo of 1944. This part of the Banditaccia has undergone a radical change in the last year or two.

Plate 31a, which is an enlargement of a part of the original air photograph of 1944, shows the central sector in this zone of 'ghost' tumuli as revealed by crop-marks along the southern edge of the Banditaccia plateau.<sup>1</sup> It makes a remark-

<sup>1</sup> After the harvest, when the tell-tale crop-marks have been cut down, these tumuli are impossible to trace in stubble (even with the air photo in one's hand), but in the autumn, when the earth is ploughed, their general positions are again revealed, this time by 'soil-marks' (useful, but less precise in outline than crop-marks). These soil-marks are clear both on the ground and from the air as roughly circular patches; in these the orange-brown soil contains an abnormally high quantity of little fragments of tufa (grey



able contrast to compare this with the ground photograph on Plate 31b, which I took in July 1947. This shows the crucial part of the same area, looking west along the edge of the plateau, with the ravine of the Fosso del Manganello on the right and the Tum. Animali Dipinti on the left (just outside the photograph). It can be seen from this picture that there is a complete absence of surface mounds; but, below the surface, the soil is full of tumuli-foundations. There could be no stronger proof than this of the fundamental importance of air photography to Etruscan archaeology, and the necessity of experience in choosing the right seasonal conditions for taking the photos.

Only one of the levelled tumuli on Plate 31a has any substantial trace of the original mound above it. This was the largest (Fig. 8, No. 5), of special interest, with a diameter of no less than 120 feet (as measured photogrammetrically from the very clear crop-mark outline of its buried tufa base). On the ground it shows a gradual rise to about 5 feet in height at its centre, as can be seen on Plate 32a, a photograph taken during my field-work at Cerveteri in 1953. The tumulus mound is indicated by the rising and falling line of the fence on the right of the trackway which crosses it diametrically. The distant figure is standing on its further circumference. The mound has been much flattened by ploughing, and still more by the new trackway which now crosses it but did not exist when my air photographs were taken. Without study, this extensive mound might be mistaken for a natural undulation in the ground, and although it is one of the largest in the whole Banditaccia necropolis this tumulus bears no special name. But the crop-marking also indicates (Fig. 8) two or even three buried entrance-passages to tombs within, and, in fact, under this tumulus lies the magnificent Tomba Moretti (the short sloping passage entrance down to it has been cleared again in the last year or so). The chief feature of this tomb is a great underground chamber cut out of the tufa, with two massive tufa columns supporting its roof. It is an impressive sight. Inside, seven smaller chambers were spaced symmetrically all round its sides, and outside there is another on each side of the doorway. It was excavated years ago, but has never been systematically published. The whole tumulus, and especially its *other* tomb-entrances, deserves greater attention.

Some of the lesser-sized levelled tumuli seen as light-toned circles on Plate 30 are probably *tumuletti arcaici*.<sup>1</sup> This small and early type of Etruscan tumulus had a circular rock-cut base, in which a narrow entrance opened down into a simple little burial chamber, excavated in the rock but covered in by an artificial roofing of stone blocks. These structures were numerous in the 7th century B.C., leading on to the larger and more complex forms of tumulus which

---

with white flecks), from the débris of the levelled mound piled above the tumulus and composed of the tufa dug out when making drum and tomb.

<sup>1</sup> The plan and section of an example can be seen in *Studi Etruschi*, I, tav. XIXA; and a good ground photograph of the squat, beehive shaped appearance of several excavated and restored at Caere is given in Prof. Pallottino's booklet (1939, p. 40) in the *Itinerari dei Musei e Monumenti d'Italia*.

reached their fullest development in the 6th and 5th centuries; and the medium-sized and larger ones revealed from the air on Plate 30 (particularly those with several passage entrances) would seem to be of this later type and period. A little later, tumulus tombs gave place to a type having a single large tomb chamber, abandoning circular tumulus construction.

I have chosen several clearly defined examples as representative of those below ground. Their crop-mark measurements, as taken from Plate 30, are as follows:—

| <i>Approximate Diameter<br/>of Tumulus in Feet</i> |    |    |                  | <i>Passage-entrances</i> |
|--|----|----|------------------|--------------------------|
| No. 1  | .. | .. | 43 <sup>1</sup>  | One                      |
| No. 2  | .. | .. | 40               | Possibly two             |
| No. 3  | .. | .. | 43               | One                      |
| No. 4  | .. | .. | 58               | Two or three?            |
| No. 5  | .. | .. | 120 <sup>2</sup> | Two?                     |
| No. 6  | .. | .. | 80               | Possibly four            |
| No. 7  | .. | .. | 35               | One                      |

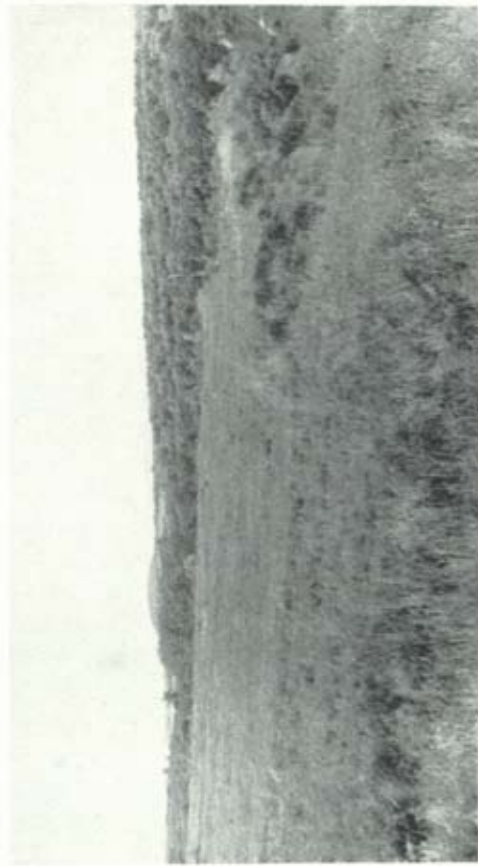
The tumuli that are shown by a plain open circle on Fig. 8 survive as obvious earthworks above ground. The largest (e.g. the T. della Nave, T. Animali Dipinti, T. Scudi e Sedie) have been restored and are fenced off. The paintings and reliefs in the tombs within them have often been described. Their mounds serve as useful landmarks when locating the positions of the levelled tumuli on foot. I have refrained from indicating the positions of tumuli and other structures inside the excavated zone, as these lie outside the scope of this chapter and require an exact ground survey.

The levelled tumuli are not visible from the air at all seasons. Out of six low-oblique air photographs of this part of the Banditaccia taken by an Italian aircraft before 1939, and kindly shown to me at the Museo di Villa Giulia, only one gave any hint of the crop-marks I have illustrated here. In addition, I examined a mosaic made from Italian vertical air photographs (with scale 1 : 9,300) taken on 1 May 1935, but not as yet published. This confirmed that these crop-markings were also visible in that year and obviously appear whenever conditions are suitable. I could see, too, the 'grass-marks' of many other levelled tumuli on the pasture-land further east along the Banditaccia plateau (beyond the area covered by Plate 30). The mosaic also showed others of the same kind on Monte Abetone nearby, to which I must next turn;—here, too, the combination of aerial photographic interpretation with field work on the ground has given very full results, which I shall now describe for the first time.

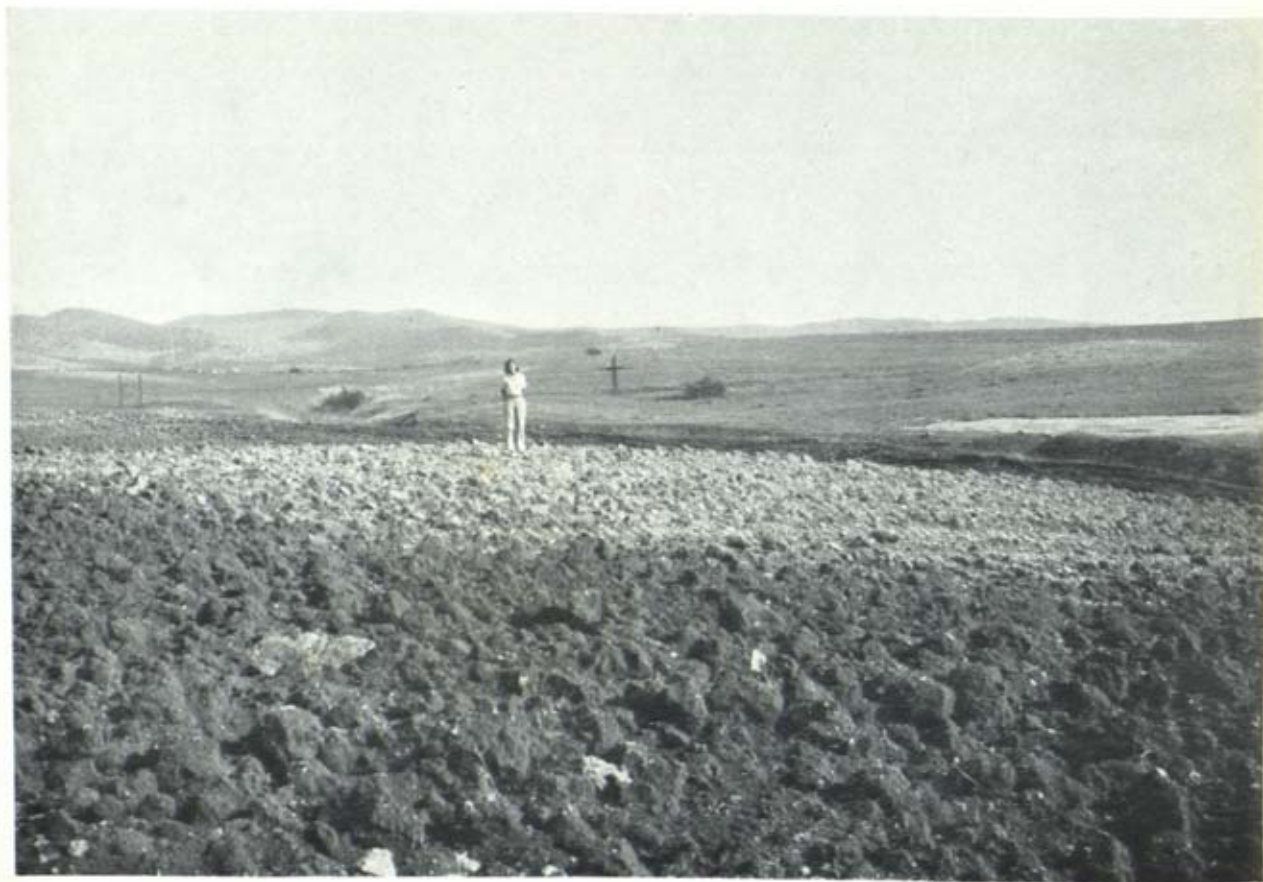
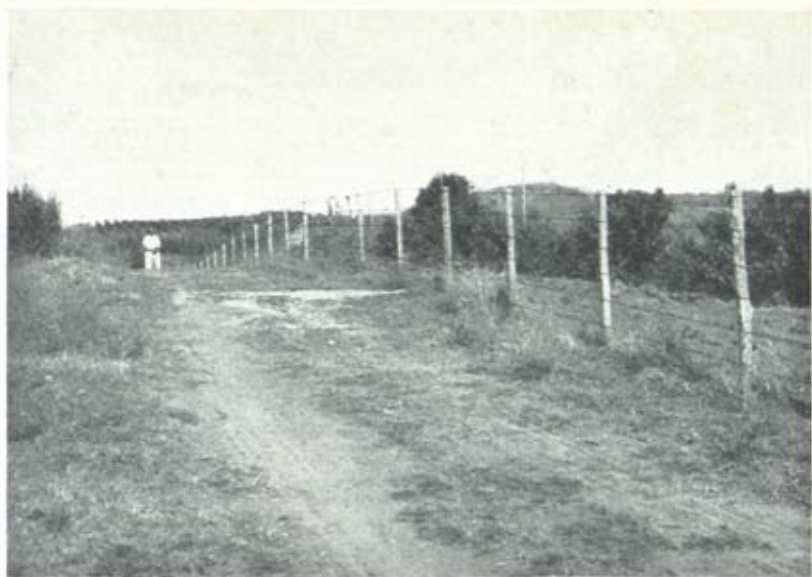
<sup>1</sup> These are not the same as Nos. 1 and 2 in my original article, which lie outside the area of Plate 30 in this book. I have very slightly revised my calculated measurements of the others.

<sup>2</sup> It may be noted, by comparison, that the largest tumulus in Prof. Mengarelli's excavations (his 'Tumulus II') measured 135 feet in diameter.





31. CERVETERI. *Above* (a) enlargement of Plate 30 to show buried tumulus foundations (white circles), entrances to them, and a major buried cemetery road (see Fig. 8 and p. 124). *Below* (b) ground photo of the same area, taken of the same south side of the Banditaccia plateau looking west, at a season when the distinctive marks in the grass had not yet appeared. The zone lies between A and B on Fig. 8. To judge from this ground photo, who would think that this level grassy field contained the foundations of more than 100 levelled Etruscan tumuli? The ground photo is a perfect proof of the value of the air view. *Ph.* (b) *Bradford*, July 1953.



32(a) *Above*. CERVETERI, BANDITACCIA. The rising line of the fence on the right shows the profile of a huge but almost levelled tumulus mound (No. 5 on Fig. 8). The buried outline of the circumference can be mapped from the air (Plate 30) and the diameter, measured photogrammetrically, is *c.* 120 feet. It contains the Tomba Moretti. (b) *Below*. COLLE PANTANO. A good example of a levelled Etruscan tumulus mound shown by a circular white 'soil-mark'. It is tumulus No. 15 in this cemetery found from the air. See Fig. 11 and p. 139. *Phs. Bradford, September 1953.*



(ii) *The Monte Abetone (=Abbatone) Cemetery.*

The plateau of Monte Abetone, which is greater in extent than that of the Banditaccia, faces the opposite flank of the Etruscan city which was thus sandwiched between these two cemeteries (see Fig. 6). Although Monte Abetone was the site of a necropolis of major importance (no less perhaps than that of the Banditaccia), comparatively little is known about it in detail and still less has been published. Scarcely more than half-a-dozen tumulus tombs (e.g. Tum. Torlonia and Tum. Campana) have been adequately explored. An air photographic plan of its layout (see Plate 34 and Fig. 9) is therefore a contribution of some value to the comparative study of Etruscan cemeteries, and has, in fact, mapped the position of 600 buried tumuli. It is essential, too, for the preparation of a proper record of levelled tumuli, to preserve them from damage.

Monte Abetone is steep sided and flat-topped,—one in the series of long, low plateaux that stretch like parallel fingers from the inland edge of the coastal Maremma plain. The cliff face of its northern edge springs abruptly from the narrow flat valley of the Mola stream (Plate 35) and is exactly matched by the scarp of the Etruscan city plateau to which it looks across. Inland, rise angular wooded hills; there is a fine view seawards and all round. About one-quarter of the surface of the plateau (at its western end) is rough pasture in which many wild plants, herbs, thistles and brambles compete with thin grass. The eastern three-quarters is arable and cultivated with corn. There is little except a few bushes anywhere on top to interrupt this great bare expanse. Conditions are perfect for aerial photographic discoveries, for the soil is very shallow above the rock. This was confirmed by the study of a number of British war-time air photographs, which covered most of the plateau.<sup>1</sup> After examining them in detail I returned in 1953 to make a careful reconnaissance on the ground of a number of features which they revealed. It is from these photographs, and not the Italian mosaic, that I have taken the details that follow.

Let us begin with the framework on which the cemetery's plan was developed. The feature of prime importance which the air photographs made clear from the start was the layout of part of its original road system. The course of two major tomb-lined roads (*vie sepolcrali*) could be identified for long distances. These ancient arteries through the necropolis lie buried today, but their line is betrayed by grass-marks and soil-marks above the deep silt filling them.

One of these cemetery roads is of particular importance (see Plates 34 and 35,

<sup>1</sup> In those taken in May and June, the levelled tumuli at the western end showed very clearly as grass-marks. The eastern portion was only covered by the June photographs after the crop had been cut, and so was less informative. A fence (marked on Fig. 9) forms the dividing line between these two areas of differing vegetation. My study of air photos in 1956 has added many more levelled tumuli, at the eastern end.

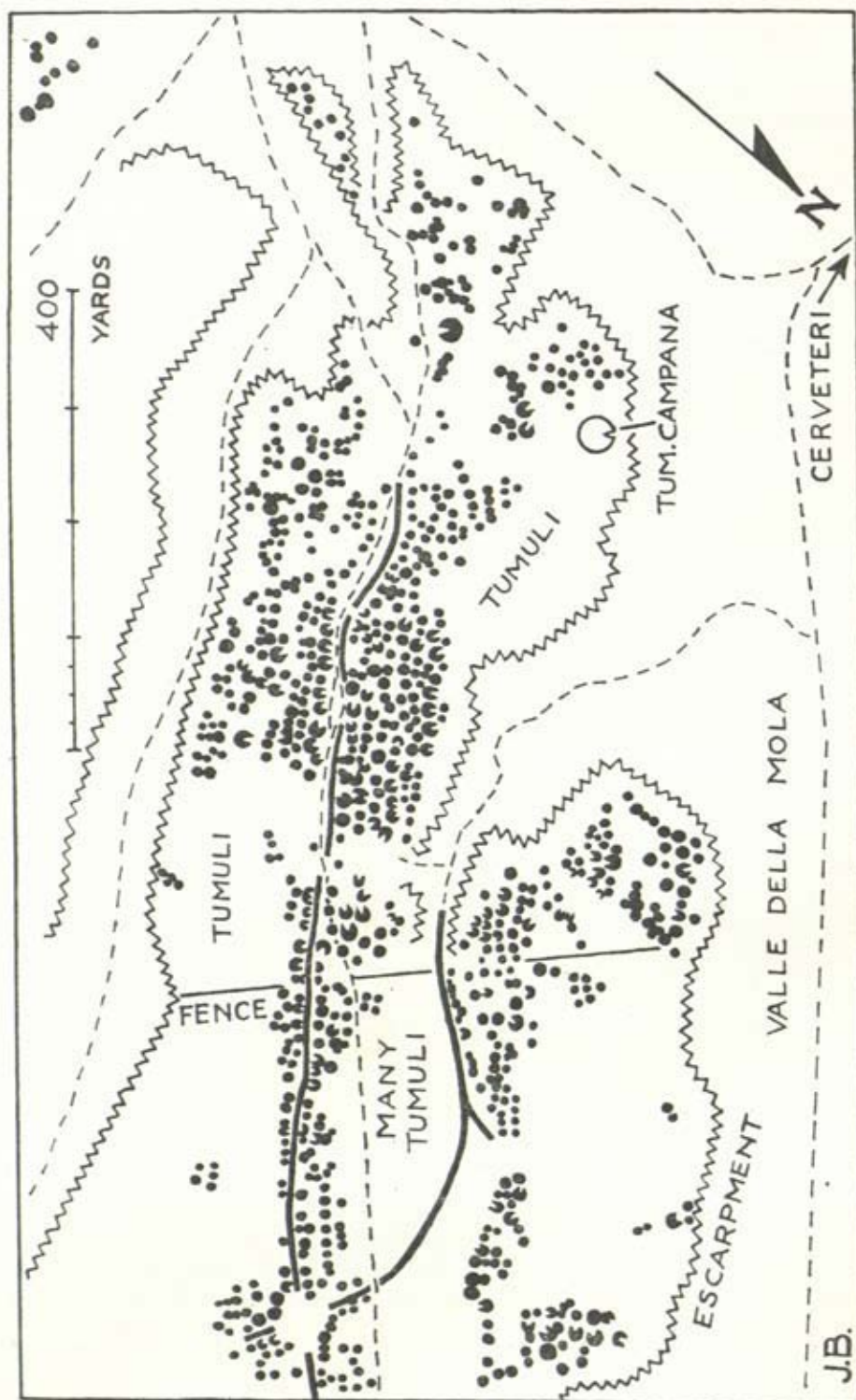


FIG. 9 Monte Abetone (Cerveteri). Plan showing the sites of 600 levelled tumuli, and two major buried roads, mapped from grass-marks in the western half of this little-known Etruscan cemetery. The photographs also showed the presence of extensive buried remains in the eastern half. ● Levelled tumulus-mound. --- Buried road. --- Roads and tracks in modern use. See Plates 34-5.



Figs. 7 and 9). It can be traced photographically (and thence on the ground) for a considerable way down the centre of the Abetone plateau and probably runs throughout its whole length. It is now apparent that the position of this great spinal road matches that of the principal one down the middle of the Banditaccia,—that which passes through Mengarelli's excavated zone and has so long been famous. The road climbs the western end of the Abetone plateau as a deeply worn trackway, here still in use (Plate 35), but from this point onwards its course is no more than a shallow grassy depression (up to 30 feet wide) whose true alignment is difficult to follow at eye level (Plate 35), unless one has the air photographs in hand as a guide. On the photographs this sacred way is defined by the circular grass-marks of buried tumuli in a continuous line along each of its margins. But on the ground this clear-cut avenue is much less obvious. True, we could catch a glimpse, here and there along its course, of a foot or two of the weathered tufa circumference of a tumulus drum protruding from the surface, with the characteristically cut moulding to ornament its edge. Of the tumuli I shall speak in a moment. Roughly parallel with the ancient road, but a little distance from it and easily distinguishable, there runs the modern farmers' trackway along the centre of the ridge.

Professor Pallottino tells me that, until now, no publication has specifically described this great cemetery road on Monte Abetone. Its course is mapped on Fig. 9,<sup>1</sup> probably for the first time with precision. This seems to correspond to an ancient road (of which no details were given) which is indicated on Mengarelli's small-scale map in *Studi Etruschi*, XI, 1937, Tav. V.

From the air we can also see that, about 1,000 yards from the point where it first tops the western edge of the plateau, this major artery is crossed by another, forming a very important road junction (see Fig. 9). The traces and causes of the outline of the second road are the same. I have followed it on the ground, but without air photographic help it cannot be termed conspicuous, until one's eyes are directed to its course. It finally curved towards a narrow re-entrant valley, cleft in the plateau's side, and continuing downwards (a path still exists) it must have crossed the Valle della Mola to reach the Etruscan city opposite. This was doubtless one of the chief routes for the funeral *cortèges* up to Monte Abetone. Upon its plateau, the surface (though flat) has undulations both natural and artificial. In areas where the air photographs are unhelpful (e.g. because the crops were harvested at the time) we are made to realise how much we depend on their evidence for identifying these roads; but even in such areas they give us some indications (e.g. soil-marks) of several possible roads in addition to those I have described. When systematic excavation begins the first stage should certainly be to take advantage of the flying-start given by the air photo-

<sup>1</sup> There is also a lesser *via sepolcrale*, on a spur still further south, which can be distinguished on the air photographs and on the ground by the traces of levelled tumuli along each side. This can be equated with markings on Mengarelli's map, and I have included it on Fig. 9 chiefly to show the great extent of the necropolis area on this side of the city.



graphs, and, with their help, to complete the details of the cemetery's road system by well-placed test-trenches. (See p. 144 for the latest discoveries.)

These roads, as mentioned, are not the only aerial discoveries. Serried ranks of levelled tumuli can be seen, tightly packed together, all over the *western* part of the plateau, as thickly clustered as in any known Etruscan necropolis. These I identified, counted, measured and planned in the same way as I did on the Banditaccia. More than 220 buried tumuli have been securely identified in this part of the cemetery alone, from British air photographs taken in the months of May and June, 1944, and their positions are shown on Fig. 9. Many are aligned in a series of symmetrical parallel rows. In a large proportion of them the exact position of the original passage entrance to the tomb below can be clearly recognised, as a dark line of brambles on the edge of the light-toned circular grass-mark caused by the tumulus drum. Several tumuli showed the markings of two of these buried tomb entrances. The photographic scale of the original prints was rather small, and although good enlargements were made these very small features cannot appear so clearly when reproduced in a book illustration. But their markings though tiny were unequivocal. Most of the tumuli measured no more than 1 millimetre on the original photographs! This made careful work essential; but with experience, as I explained in Chapter I, such very detailed examination is quite an ordinary matter, given good prints under strong magnification. Many of these tumuli have been opened and robbed.

These levelled tumuli are mostly of small to medium size; varying between 30 to 45 feet in diameter, measured photogrammetrically across the grass-mark of the circular foundation-drum. One, at least, is 50 feet across. Such measurements can be trusted to be accurate, and I will give an instance. In 1953 I measured a typical example on the ground; the edges of its drum were visible at a few points (the surface soil being eroded by rain and weathering). Its diameter was exactly 42 feet. Measured from air photographs of 1 : 13,000 scale, taken from a height of several miles, it was 0.9 of a millimetre across, equal to 40 feet at this scale. A ground-photograph of the circular grass-mark above this tumulus, which I took on the same occasion, is reproduced on Plate 35b. The grass-mark was due to differential growth. It consisted of a roughly circular clearing among tall grasses, weeds and thistles, and corresponded to the outline of the tumulus drum of tufa. All but the last inch or two of surface soil had been washed off the top, on which only small creeping plants and dwarf kinds of grass could exist. The contrasts of natural vegetation were exceptionally clear on the ground, and it is not surprising that such features can be well mapped from the air. The taller grasses, of course, flourished above the deep soil surrounding the tumulus, where the tufa had been cut out in order to leave the drum free-standing. In various parts of the necropolis the photographs also showed several grass-markings of angular-shape, and these indicate large structures of a different form (varieties of later *tombe a camera*, etc.).

I must not weary the reader with an excess of detail. It is not possible here



to list the dimensions and individual details of all the tumuli found, but it is, however, essential to emphasise that such a list and a large-scale plan *could* be drawn up.

If further suitable photographs were taken at other times of the year to extract the full total of tumuli from the *eastern* two-thirds of Monte Abetone, there is no doubt that one could add the positions of other buried tumuli by hundreds. If under corn as usual, early in May would be the best season. My air photographs<sup>1</sup> gave strong indications of the great potential importance of that part of the plateau, for (even when only covered by stubble in June) it had the same, typically diagnostic, 'mottled' appearance which the tumuli-filled areas on the Banditaccia also show after harvest.

Today, a full knowledge of the plans of cemeteries is urgently needed in order to take measures to save buried and un-recorded sites from damage by agricultural schemes (see p. 141).

### TARQUINIA

The Monterozzi necropolis,—probably the largest single continuous zone of tombs in Etruria,—lies 42 miles N.W. of Rome, and further up the coast beyond Cerveteri. The cities of the living and the dead anciently confronted one another across a wide valley among the lines of low hills which rise from the back of the coastal plain as at Cerveteri. Here too, at Tarquinia, the position was a favourable one for a city-state that was both a land and sea power. Parallel with the plateau called the 'Piano di Civita'<sup>2</sup> where the old city stood, there runs the longer ridge on which its great necropolis lay. This was wedge-shaped, tapering to a point on which is poised the modern town (styled since 1872 Corneto-Tarquinia), with its sheaf of medieval towers looking down on the Maremma plain. From the outskirts of the town the necropolis extends for no less than 2 miles up to 'Secondi Archi', with a probable addition of a further half-mile beyond that point towards the spot called Pisciarelllo. We shall concentrate on the central sector of this necropolis (Plate 36). Today, it is for the most part a great expanse of unfenced ploughland, but there are three convenient fixed points of reference, Primi Archi, Arcatelle and Secondi Archi (see Fig. 10),—the remains of a medieval aqueduct. 'The whole surface is rugged with tumuli, or what have been such but are now shapeless mounds of earth', wrote Dennis,

<sup>1</sup> They also show other features of interest, including a long sector of the ancient road from Caere to Pyrgi which is visible as a soil-mark between the Tenuta di Zambra and the Montetosto tumulus (for this road, see *Studi Etruschi*, XI, Tav. V, map).

<sup>2</sup> The site of this city has potentialities for air-photographic discoveries (as do other Etruscan towns, for example Vulci). Its plateau is level and open, without any encumbrance of olives or vines; and the outlines of buried buildings are visible as crop-marks or shadow-sites, at the right season of the year or time of day. But Roman occupation is a complicating factor.

For an account of sporadic excavations on the city plateau, and its problems, see M. Pallottino in *Monumenti Antichi*, 1937, 86 seq., 559 seq.; and Dennis, *op. cit.*, vol. I, 424. For the latest excavations in the city, see P. Romanelli in *Notizie degli Scavi*, 1948, 192 seq.



'giving to the hill, even when seen from afar, a strange pimply appearance',<sup>1</sup> and thence comes its name, Monterozzi. In his day it was still rough pasture sprinkled with myrtle, wild olive and broom; but it has since become arable and every year the plough has still further erased the tumuli mounds,—in many cases completely.

Dennis, with his quick eye for the potentialities of terrain, gives a valuable picture of the state of the cemetery a hundred years ago when it was being ransacked, and describes the scene in the same clear-cut manner as his contemporary Edward Lear<sup>2</sup> would have drawn it. 'Wide sweeps of bare country on every hand,—the dark, serrated range of the Tolfa hills to the south,—an aqueduct of many arches in the foreground; and the sunny blue of the Mediterranean, the only cheerful feature in the landscape, gleaming on the horizon'. On ascending the Monterozzi 'the strangely broken surface of the down at once arrests the eye'. Separated from it by a deep vale stretches a parallel ridge, browed with white cliffs, the site of the Etruscan Tarquinia; seaward lies the plain, stripped of its ancient woodland, surveyed by the battlemented walls of Corneto; beyond and northward up the coast the bold headland of Monte Argentario, and in clear weather even the peaks of Elba remote and grey on the horizon. The whole scene is tinged with the comfortable melancholy of the Campagna,—the kind of solitude that combines a sense of space with that of intimacy, so agreeable to latter-day diarists,<sup>3</sup> though misleading if too uncritically transposed to the scene of the active cities and fields of the Etruscan landscape.

Once again it is necessary to refer to the prolonged rifling and destruction of tombs and tumuli in order to emphasise fully the present necessity, and unusual difficulty, of drawing-up a comprehensive plan of the cemetery that will show all the chief tumuli, ancient roads, etc. If it were not for the air photographs one might well despair, for so many of these structures have only the slightest surface indications remaining. But a determined effort is essential *now* to mitigate, and to end, the inheritance of confusion from the past, if we are to put future work on a sound footing. All that was previously known of the Monterozzi necropolis, and of the smaller scattered cemeteries on hillsides round the ancient city has been collated and summarised with un-rivalled care and skill by Professor Pallottino (*Monumenti Antichi*, XXXVI, 1937, 6-616), who divided the history of exploration here into three phases. (1) Haphazard looting and sporadic digging doubtless began in Classical times. Individual episodes can be documented with dates from 1489 onwards; precious metals and other grave-goods were on several occasions utilised by Renaissance Popes as a convenient

<sup>1</sup> *Op. cit.*, vol. I, p. 302.

<sup>2</sup> Both men were exploring the Campagna with equal energy, on foot and by 'diligence' during the 1840's, sketching a countryside that was still wild enough. One wonders if they ever met, perhaps, at the dinners and receptions given by the numerous and wealthy English colony in Rome. Lear's *Views in Rome and its Environs* was published in 1841. Dennis began his tours in 1842.

<sup>3</sup> See *The Times*, 7 February 1953.



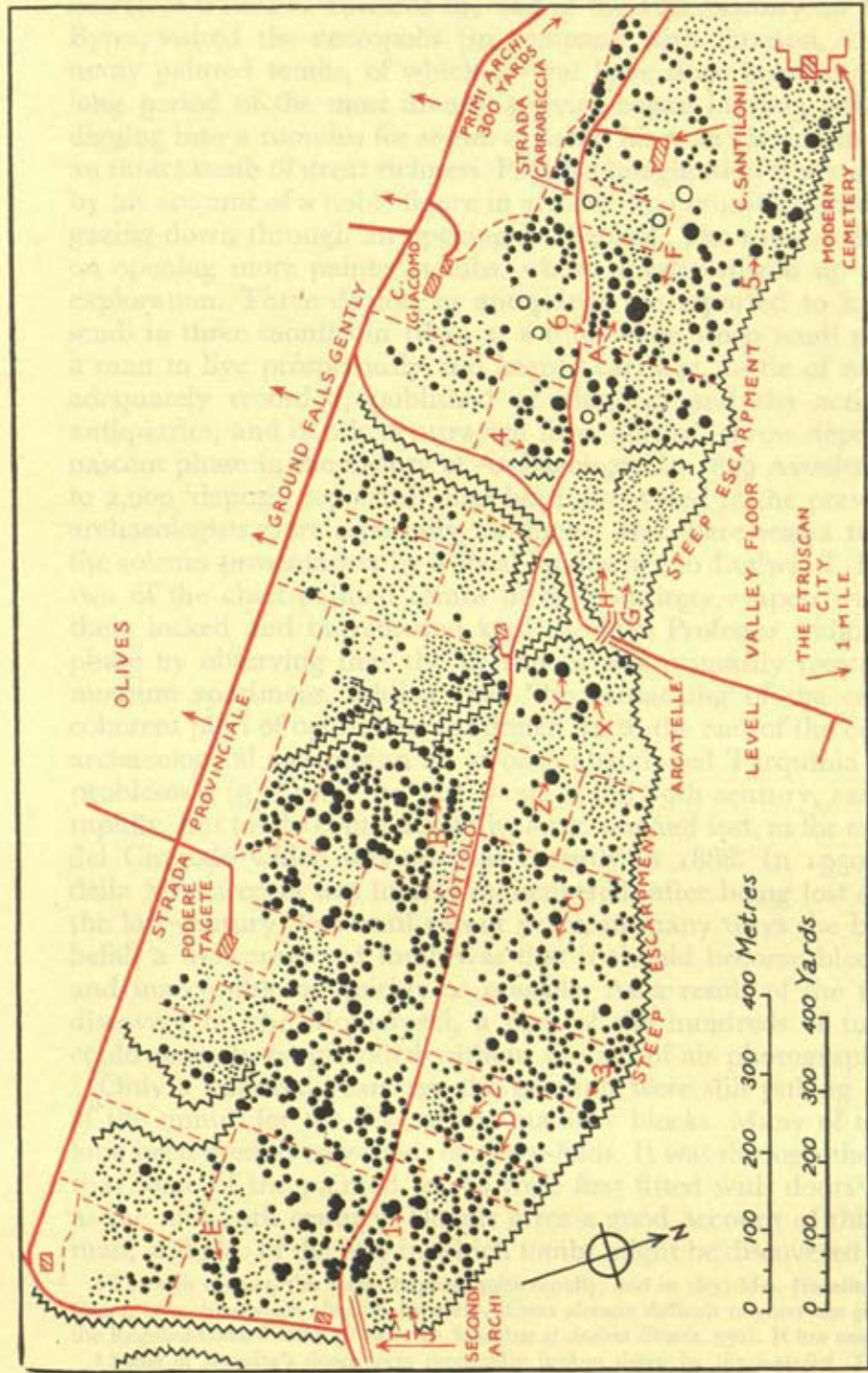


FIG. 10 Monterozzi (Tarquinia), 42 miles N.W. of Rome. Map of 800 levelled tumulus-mounds, etc., in the central portion of the Etruscan cemetery, which were located from soil-marks. See Plates 36-7. This map is based on air photo interpretation by the author.

- = Position of levelled tumulus-mound (for Nos. 1-6 see p. 137)
- = Well-preserved tumuli, as landmarks (for X, Y, Z see p. 138).
- ⋮ = Zones in which fainter traces of many levelled tumuli are visible from the air.
- A to J = Ten buried Etruscan cemetery roads, revealed by alignments of levelled tumuli.
- ~~~~~ = Edge of slope.
- = Roads in modern use.
- = Field-boundaries.





source of treasure. Towards the end of the 18th century an Englishman, James Byres, visited the necropolis (in company with Piranesi, it is said) and drew many painted tombs, of which several have since been lost. (2) *c.* 1823-81. A long period of the most intense activity began in 1823, when Avvolta (while digging into a tumulus for stones to mend his road) accidentally penetrated into an intact tomb of great richness. Popular imagination was startled and intrigued by his account of a noble figure in armour that crumbled into dust while he was gazing down through an opening in the roof. The town council became intent on opening more painted tombs, whose novelty stirred up a sudden frenzy of exploration. Three dealers in antiquities are reported to have cleared 40,000 scudi in three months in 1830, at a time when 1,000 scudi per annum enabled a man to live prosperously and keep a carriage. Little of such excavation was adequately recorded, published or planned, and the activities of the local antiquaries, and of others attracted from abroad, throw depressing light on this nascent phase in the history of Archaeology. In 1839 Avvolta estimated that up to 2,000 'depositi sepolcrali' had been discovered in the previous year. German archaeologists were especially assiduous; and there was a touch of comedy in the solemn presentation by a local landowner to Ludwig I, King of Bavaria, of two of the chief painted tombs in their entirety,—upon which the King had them locked and barred, and kept the key. Professor Pallottino sums up this phase by observing that the necropolis was primarily treated as a quarry for museum specimens, adding that 'the ransacking of the cemetery without a coherent plan of operations continued up to the end of the century, when fickle archaeological enthusiasm all at once abandoned Tarquinia for other sites and problems'. (3) From the last years of the 19th century, excavation decreased rapidly. But tombs continued to be forgotten and lost, as for example the Tomba del Citaredo which was open as recently as 1888. In 1930 the large Tomba della Mercareccia was luckily rediscovered, after being lost since the middle of the last century. But until recent years, in many ways the best fate that could befall a well-preserved tomb was that it should become blocked with rubbish<sup>1</sup> and inaccessible as quickly as possible. As a result of the troubled history of discovery on the Monterozzi, a map of the hundreds of tumuli now levelled could scarcely be provided without the aid of air photography.

Only a hundred years ago the peasants were still pulling to pieces the bases of the tumuli for the sake of the masonry blocks. Many of the best tombs had long been used as cow-sheds or sheep-folds. It was through the energy of Avvolta that some of the painted tombs were first fitted with doors<sup>2</sup> and locks, as late as the mid-19th century. Dennis gives a good account of this lively old gentleman, and also of the way in which tombs might be discovered and yet disappear.

<sup>1</sup> Through neglect, this might happen quite rapidly, and in 1839 Mrs. Hamilton Gray reported that at Caere, only three years after its discovery, it was already difficult to enter the passages and chambers of the Regolini-Galassi tomb (*Tour to the Sepulchres of Ancient Etruria*, 352). It has now been cleared.

<sup>2</sup> Some of Avvolta's doors were repeatedly broken down by the *contadini*. The tumulus tombs were also used by vagrants and sheep-stealers in hiding.



Thus, once, when prowling 'among the countless mounds and pitfalls that chequered the surface of the Monterozzi' he came upon a pit 6 feet deep, overgrown by lentiscus; 'at the bottom was a hole barely large enough for a man to squeeze himself through'. Dennis wormed his way down and by a taper's light recorded the painted scenes in the 'Tomb of the Black Sow'. Although formerly accessible, its site was unknown to the *custode*. Such a disappearance, and that of other painted tombs and whole tumuli, was often accidental. On the other hand some were purposely concealed, and it was no uncommon thing for a stranger, on making the tour of the Monterozzi, to be accosted by some labouring man who would promise to open for him a painted tomb, 'which nobody else had seen', for the *douceur* of from 20 to 50 francs.<sup>1</sup>

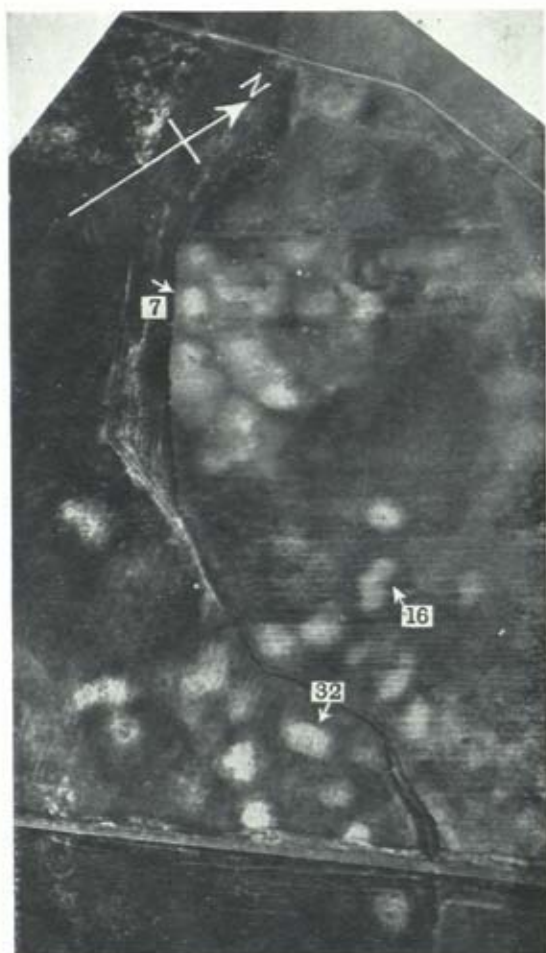
For the atmosphere of 19th century Etruscology, and the background to the problems of planning the Monterozzi necropolis today, the ingenuous but honest impressions of Mrs. Hamilton Gray in 1839 add some details of interest for the archaeology of Archaeology:—although her occasional moralisings about 'the march of discovery', as applied to the diggings of the treasure-hunters, are decidedly reminiscent of the 'March of Mind' and the 'Learned Friend', attitudes wittily satirised by Peacock in *Crotchet Castle* a few years before. But she gives interesting eye-witness accounts of contemporary methods<sup>2</sup> of excavation (e.g., at Veii). 'The foreman of the labourers took his pick-axe and struck the ground in many places but it resounded to the tufa'. Eventually, by combined probing and 'bosing',<sup>3</sup> 'the foreman found the earth deep. He then searched about until he came upon tufa and distinctly traced upon the grass the part where the tufa and soil met upon the upper line of a door'. Filling-in might have to be done the next day to restore the land for sheep grazing. 'When this generation has passed away, what is there to preserve the memory of the ground they hired, searched and filled in again . . . and who is to say what was found in any particular tomb . . . or what ornaments are contemporary and were found together?' 'In fifty years time the men who opened it, and those who saw it opened, will be no more'. 'No plan has ever yet been made of the ground explored'. There is a curiously modern note of regret in such comment. She also observed that the smaller, earlier tumuli more often contained rich burial goods than the larger and more prominent ones which had invited spoliation (adding

<sup>1</sup> Dennis, *op. cit.*, Vol. I, 384.

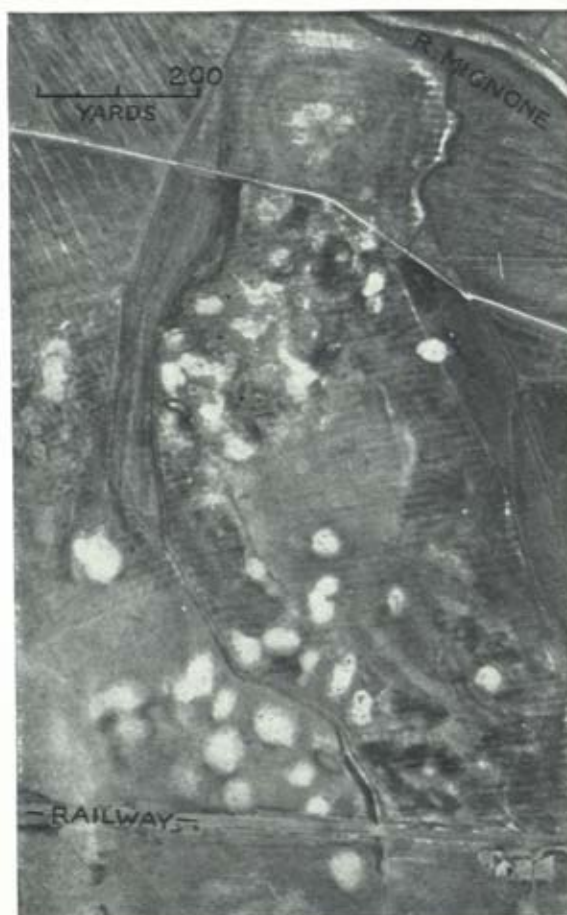
<sup>2</sup> All the chief dealers had staked out their own excavations at different cemeteries, and so also had the great landowners (including Lucien Bonaparte, recently settled in Etruria). There is a memorable description of the veteran collector Campanari returning from the day's digging, mudstained but in dignified black at the head of his men with their mattocks, on the way to his garden full of sarcophagi and reconstructed tombs. His whole house 'teemed with sepulchral baked clay'. There were quantities of white rabbits running about in the garden, which jumped out unexpectedly from among the *bassi rilievi*, vases and broken marbles. Some people found this disconcerting, but Campanari said that he 'thought them appropriate, for they were animals that loved sepulchres and were constantly found among the graves'!

<sup>3</sup> A method occasionally useful where the rock lies close to the surface. When this is thumped with a weighted rammer the sound given has a dull tone; above deeper soil (filling an ancient ditch) the tone is more resonant.





(a)



(b)

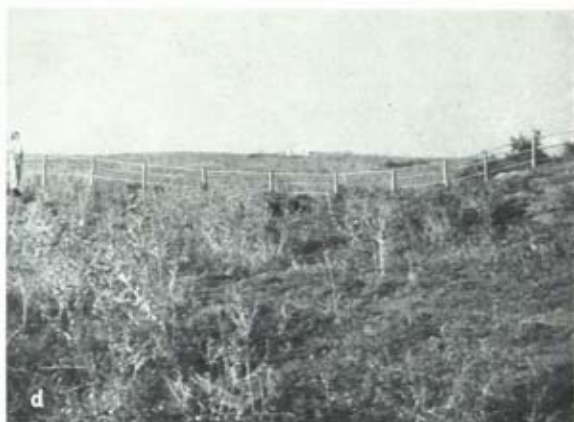
33. COLLE PANTANO, midway between CIVITAVECCHIA and TARQUINIA. Vertical views showing symmetrical white soil-marks indicating the positions of about fifty Etruscan burial mounds, levelled by ploughing. Some appear to be grouped in twos or threes (e.g. No. 16). These air views gave the first map of the cemetery. Eastward from No. 7 an alignment and a dark line suggest a buried cemetery road. Comparative photos are valuable for a detailed study: (a) 5 April, 1943, (b) 18 May, 1944.

See Fig. 11 and p. 142. *Crown Copyright Reserved.*



34. CERVETERI, MONTE ABETONE. Vertical view (11 May, 1944) showing (i) the positions of hundreds of buried Etruscan tumulus-foundations revealed by the white circles of parch-marks in grass; (ii) the dark outlines of buried Etruscan roads meeting at a junction, i.e. the large dark area marked 'A'. Cloud-shadow is a limiting factor, but in spite of this the photograph is of great archaeological value. See Fig. 9 and p. 127. *Crown Copyright Reserved.*





35. MONTE ABETONE. (a) View of the north side of the plateau occupied by the Etruscan cemetery, facing its city (see Fig. 9). (b) The figure stands on a circular patch of sun-burnt grass, typical of the 'grass-marks' which have revealed 600 buried tumulus foundations on this site. A growth of tall weeds outlines the deeper soil which surrounds its circumference. (c) A trackway climbing the western end of M. Abetone, the beginning of a major Etruscan road along the centre of the cemetery. (d) A view along its continuation, 550 yards to the east, where buried and under grass. The fence crossing it (marked on Fig. 9) shows its sunken line. The air photo on Plate 34 has mapped its course, bordered by buried tumuli. *Phs. Bradford, September 1953.*



36. CENTRAL ITALY, MONTEROZZI. This vertical view surveys an area measuring one mile in length, at the centre of this immense Etruscan cemetery 42 miles north-west of Rome. The hundreds of white patches on the bare ploughed soil are typical soil-mark sites. They show the positions of tumuli whose stony mounds have been partly or completely levelled by cultivation. This photo made it possible to map their layout more fully than ever before. See p. 131 and Fig. 10. *Crown Copyright Reserved.*



characteristically, 'thus the lowly cottage stands, while the high towers fall'). It is certainly important to emphasise that some of the many smaller levelled tumuli revealed by air photography should still be of special significance for this reason.

The absence of a general plan of the site long continued to be a serious difficulty, and imposed limitations (as late as 1934) on Akerström's discussion of the distribution of tomb types here in his *Studien über die Etruskischen Gräber*. It was not until 1937 that a beginning was made, with the sketch-plans<sup>1</sup> in Professor Pallottino's authoritative publication. These were based on the monuments most obviously recognisable at eye-level today and as many of those previously recorded as can now be identified. But, in spite of their great value, it is important to keep in mind that they were only intended as sketch-plans, being (unavoidably) approximate and generalised in various ways. In view of the immense difficulties in mapping so large an area as the Monterozzi necropolis, some inaccuracies and omissions were bound to appear when comparing the results of ground examination with vertical air photographs. The latter supply the basis for a comprehensive site-plan with a very high degree of accuracy and detail. It is, therefore, in no captious spirit, but rather to supplement his praiseworthy efforts, that I must indicate some corrections to be made in Pallottino's topographical<sup>2</sup> framework. The new light on the distribution of the tumuli is, however, of greater concern. The air photographs show a considerable number of tumuli, clearly and exactly located, on every side of the Casa Santiloni (see Fig. 10). Their outlines can be very clearly seen as small, light-toned, circles; and with the help of the air photographs these can all be identified on the ground. Without such help, at ground level, one only has a confusing impression of minor undulations and changes in soil colouring,—and it is difficult then to distinguish individual structures, as I was able to see when examining the surface in 1945. We can thus make extensive additions to Pallottino's map of this part of the necropolis, with numerous tumuli not marked by him. Although their mounds are so much levelled<sup>3</sup> there is no doubt as to their existence, and they are as much a part of the cemetery as those whose mounds are better preserved and well-known.

<sup>1</sup> In *Monumenti Antichi* (R. Accademia Nazionale dei Lincei), vol. XXXVI, plates IV-VI at end of volume. Prof. Cultrera had earlier begun the system of numbering the tombs in a progressive sequence; see also Romanelli, *Not. Scavi*, 1943, 213 seq.

<sup>2</sup> E.g. (i) The track (*viottolo*) between Arcatelle and Secondi Archi, which is an important landmark, is straight and has no change in direction midway. (ii) The line followed by the edge of the escarpment ('ripa calcarea') which forms the principal boundary of the necropolis is inaccurately planned (whether its top or its bottom is shown). (iii) The line of the east arm of the Y-shaped valley (known to have been a *via sepolcrale*) running from Arcatelle to the Strada Provinciale is much more irregular than is indicated.

Such topographical details are important, if the tumuli are to be positioned correctly. Further, some of the large tumuli marked by him about half-way between Casa Santiloni and Arcatelle on each side of the trackway need corrections in their positions relative to one another.

Moreover, the scales of distance on his two sketch-maps that cover the areas between Primi and Secondi Archi are also only approximate, the scales being demonstrably too small when checked with measurements both from the Italian 1 : 25,000 map and from the vertical photographs.

<sup>3</sup> See latest proofs in 1946-7 by drilling, p. 144.



In his careful reconstruction of the plan from the available sources, Professor Pallottino fully recognised the inherent limitations of the evidence, and the misleading appearances that it might create. Of the Arcatelle area he wrote, 'Here, also, the lack of precise indications for the most part prevents the exact topographical localisation of the tombs that have been discovered and described: with the result that the archaeological plan is compelled to be silent, when in reality it should be nearly black with distribution spots'. The wisdom of his judgment is confirmed by Plates 36 and 37.

In the sector between Arcatelle and Secondi Archi the air photographs make an even more decisive contribution, adding several hundreds of tumuli and tumuletti to those mapped in *Monumenti Antichi*. Their density and number are not surprising when the centuries of use are remembered, and their irregularly scattered distribution to fill up every space is also to be expected. Although successive phases of use may have obscured some of the early layout of the cemetery roads, the air photographs (which throw fresh light on the course of several) do not give any support to the supposed elaborate planning of the roads through the major Etruscan cemeteries, imagined by some to foreshadow Roman rectilinear gridded plans.

Thus, in the areas for which only a generalised indication of 'Zona di Tombe' was previously marked by Professor Pallottino we can now point with precision to the positions of tumulus-foundations below the surface. Some parts of the necropolis reveal them more clearly than others do; and, obviously, we should learn more from photographs of still larger scale, or from those taken for the purposes of comparison in successive years when differing conditions of vegetation existed. Such comparative study is of the greatest importance in building-up the plan.

At this point, some further details about the photographs themselves are desirable. The photographs illustrated here were taken on 16 February 1944, at a time of the year when the cultivated fields along the top of the Monterozzi ridge had only a very thin covering of young growing corn. The light-toned patches which indicate the tumuli beneath are, as I have said, caused by 'soil-marks'; a normal archaeological phenomenon which has already been discussed in Chapter I. After examining the surface of the Monterozzi on foot, I was able to confirm that these paler patches are due to an increase in the proportion of stony rubble in the soil at these points, and that they represent the ploughed-out mounds of levelled tumuli, which had originally been built up from the rock habitually excavated all the way round the foot of the foundation-drum. These 'soil-marks' are *in no way*<sup>1</sup> connected with farming activities or with the excavations of early antiquarians. Although the presence of such circular stony areas is clear on the air photographs, these areas are by their nature difficult to

<sup>1</sup> Practice makes it possible to distinguish accurately the appearance of the archaeological features from the normal surface-markings caused by patches of rock outcropping at ground level, and to eliminate all such markings from consideration.



measure exactly, as they shade off gradually into the normal texture of the undisturbed earth; and thus they are far less helpful than are the crop-markings and grass-markings at Cerveteri. Further, the passage entrances to the tombs under the tumuli are not well shown by soil-markings, as contrasted with the way in which crop-markings outline them clearly. Soil-markings, therefore, provide only an approximate plan of structures.

These soil-markings were still very clear on air photographs taken on 29 March, but others taken on 31 May showed that a covering of crops had, in this instance, not helped matters archaeologically, and (curiously enough) there did not seem to be any tumulus outlines due to parching, like those photographed at Cerveteri on 14 May in the same year. Between Primi Archi and the town there was little to be seen except a few suggestions of small tumuli, and south of the Strada Provinciale in the olive plantations there were no important discoveries, excepting a few circular soil-marks in the neighbourhood of the outlying Tumuli della Doganaccia; the scarcity of markings here is perhaps due to the deeper soil on this slope. As I have emphasised already, it is not enough to fly over the area with an air camera; experience and attention to the special problems of the site and its terrain are required for successful photography.

In some cases the outlines of the tumuli are sufficiently clear (even in their ploughed-down condition) to make it possible to estimate their diameter approximately. The dimensions of six specimen examples have been calculated from vertical photographs having a scale of 1 : 6,500, to give an indication of the size of the others seen throughout the necropolis. They are indicated by numbers on Fig. 10.

|       |                                  |   |    |
|-------|----------------------------------|---|----|
| No. 1 | Approximate diameter in feet, 50 |   |    |
| No. 2 | "                                | " | 30 |
| No. 3 | "                                | " | 60 |
| No. 4 | "                                | " | 50 |
| No. 5 | "                                | " | 60 |
| No. 6 | "                                | " | 25 |

Between the east wall of the modern town's cemetery near Primi Archi, and Secondi Archi (a distance of about 1,650 yards), the soil-marks of well over 800 tumuli, large and small, have been counted on Plate 36; and a number of probable ones could be added to this figure. Pallottino stated that remains of about 100 levelled tumulus-mounds were visible between Primi and Secondi Archi. Westphal in 1830 said that some 600 of their rounded profiles were recognisable on the Monterozzi. Many are still obvious as low mounds.

The certainties can be subdivided as follows:—(i) *c.* 130 on the north side of the Strada Carrarechia, between the cemetery and Arcatelle; these include a number of good-sized tumuli near Casa Santiloni which do not appear on the plan published in *Monumenti Antichi*, and so it is not now necessary to write of this

area:—‘we must be satisfied to place the monuments in a more or less vague zone outlined with the greatest approximation’. (ii) *c.* 90 on the south side of this road; some being particularly clear. (iii) *c.* 270 on the north side, and (iv) *c.* 320 on the south side of the modern trackway between Arcatelle and Secondi Archi. Here, the soil-marks of ploughed-out tumuli are so numerous that the ground, on this air photo, appears as if covered with snow. A few of the largest (e.g. X, Y, Z) can be equated with some shown on Pallottino’s map.<sup>1</sup> He indicated the presence of three *Zone di Tombe* in this part of the necropolis, but the vast majority of the tumuli-markings are securely positioned for the first time by our present illustration. Some still possess surface remains of their much levelled mounds. Such mounds stand out slightly in relief under stereoscopic examination, which was found very useful in studying this necropolis. The big gaps on Pallottino’s Tavola VI are now filled. (v) Inside the big triangular area between Arcatelle and the Strada Provinciale the soil-marks are faint, but nevertheless a number of tumuli can be identified in this important zone in which some famous tombs have been recorded.

This photograph, however, gives no indication of the presence of such small features as the holes dug for archaic *pozzetti* graves, several hundreds of which were excavated near Arcatelle. It is not in any way claimed that aerial photography alone is self-sufficient to plan a site of this kind; it must be combined with much field-work (trial-trenching at selected points, electrical-resistivity surveying, and mechanical drilling), and the full use of the literary sources which have been summarised in Pallottino’s monograph. The combination of all the methods of modern archaeological field-research is required.

The topographical evolution of the necropolis, which was spread over more than five centuries, is said to have involved a gradual swinging of the heaviest concentrations of tumuli from the east to the west end of the Monterozzi. But it was not an orderly process; the same holy ground was used and re-used, until saturated. The area shown on Plate 36 is known to have been much favoured for tumuli in the VII-V centuries B.C. It is probable that numbers of these soil-markings belong to this period.

Finally we come to the most important of these additions to our knowledge of the site. I refer to the ten (or more) alignments of levelled tumuli, indicating cemetery roads, whose course has now been defined. One of these, at A (Fig. 10 and Plate 36), bifurcates to form two branches; the longer arm can be detected as running westward for about 110 yards; and in the opposite direction it can even be traced continuing eastwards (road H) as far as Arcatelle, almost 400 yards distant. Two more cemetery roads are identifiable at F and G, as lines of darker tone caused by the earthy silt that fills them and contrasts with the stonier tumulus débris along each side. Another is indicated by an alignment

<sup>1</sup> On Fig. 10 I have not attempted to identify the positions of the various individual tombs (as distinct from tumuli) scattered over Pallottino’s map, because it is naturally not practicable to identify the former on air photographs without extensive field-work on foot for this special purpose.



of tumuli at B for 130 yards, and perhaps further still. Professor Pallottino suggested that there was a cemetery road along, or near, the northern edge of the escarpment between Arcatelle and Secondi Archi, and there are several long tumulus alignments visible in this area (Fig. 10 and Plate 36), notably at C, D, E and I. There is every reason to believe that these indicate interesting stretches of cemetery roads, not previously planned. Such discoveries should prove most useful. With a limited amount of test-excavation at vital points, selected with the aid of the present air photographs, much could be done to establish the road-plan. Such a programme of planned test-excavation, even on a small scale, would bring results of great value. It is the essential counterpart and accompaniment to the policy of the total stripping of large individual areas as at Cerveteri today, and would be of equal value archaeologically.

### THE COLLE PANTANO CEMETERY

At a distance of  $5\frac{3}{4}$  miles (c. 9 km.) south of Tarquinia, air photography has brought to light the plan of an Etruscan cemetery, between the modern Via Aurelia and the sea, which can aptly be named from the 'marsh hill' on whose slopes it lies. Although it is small when compared with the Banditaccia or Monterozzi cemeteries, the soil-marks (see Plate 33) which indicate the presence of tumuli here are particularly clear and important. The reasons for such appearances on ploughed soil have already been explained. For comparison, Plate 32b gives a ground view of a typical marking, photographed when I examined the site in October 1953.

Although the railway line to Rome down the coast actually cuts a corner of the site, the surrounding area has until lately been very remote with only an isolated farm here and there; and the relatively deserted nature of the region long kept it little known, archaeologically. The cemetery covers two low parallel ridges which side by side project into the wide zone of marsh (*pantano*) along the River Mignone, with the sea scarcely more than a mile away. Inland, Tarquinia and its great necropolis stand up well as landmarks on the hills.

The tumulus distribution fills a roughly triangular area, about half a mile across on its longest axis (from west to east). The Colle Pantano cemetery also extended a little way beyond the railway line, on the opposite side, but a modern farm has obscured this. I have examined a number of air photographs covering this area, between Civitavecchia and Tarquinia, and no other Etruscan cemetery-sites of comparable importance were seen. However, several smaller groups of levelled tumuli were observed, notably one containing about a dozen very clear, circular, soil-marks at a spot significantly called 'Casa dell' Uomo Morto' (Dead Man's House) 900 yards S.S.E. of the Colle Pantano group. We may note that Pallottino, in his *Etruscologia*, has remarked of this region that 'there were many small Etruscan settlements on the Tolfa hills, and at their foot, that merit exploration'.

When I first described these two cemeteries in *Antiquity*, June 1947, I did so from the evidence of the air photographs alone, and my identification of them from the characteristic soil-markings was necessarily tentative until I could gather ground information. Shortly afterwards Professor Mancini kindly drew

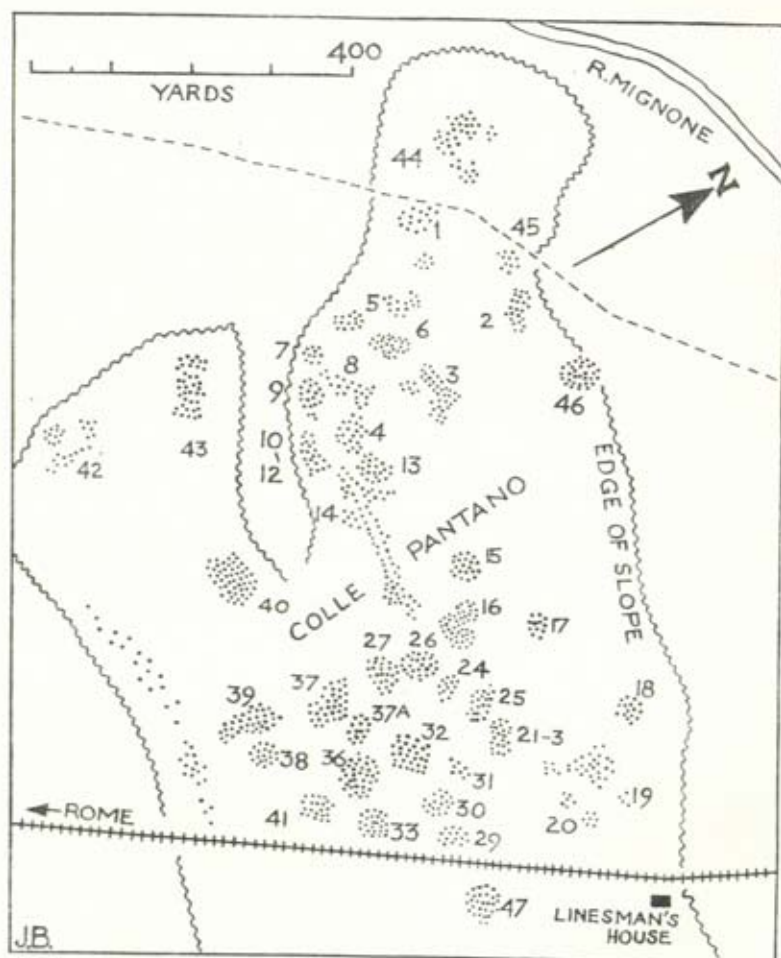


FIG. 11 Colle Pantano (9 km. south of Tarquinia), an Etruscan cemetery first mapped from the air. Soil-marks indicated the positions of about 50 tumulus-mounds now levelled, and a probable buried cemetery road between Nos. 9 and 26. The railway line to Civitavecchia passes the site. See Plates 32b and 33.

my attention to a brief note by Mengarelli in *Notizie degli Scavi*, 1941, XIX, p. 345;<sup>1</sup>—a war-time volume that was not available in Oxford when I wrote the article mentioned. I now find with pleasure and interest that Mengarelli had indicated evidence for a cemetery at both these points, and it is very satisfactory

<sup>1</sup> His map (Tavola I) shows the position of Colle Pantano, in relation to neighbouring sites along the coast.



that direct interpretation from the air photographs thus received unexpected confirmation from an independent source. It shows, again, that air photographic interpretation can be a true and reliable guide in Etruscan archaeology.

Mengarelli's report was, however, no more than the briefest note. Having given the position of the sites, he continues, 'Both cemeteries are characterised by tumulus mounds built of fragments<sup>1</sup> dug from a white rock, gypsum or selenite, of which extensive formations are found in the vicinity. The exploration of the Pantano necropolis was begun but later abandoned, and should be re-started'. From this description, the cause of the extreme whiteness of the soil-marks on the photograph can be readily understood. Tumuli cut from gleaming gypsum would certainly be a novelty! According to Mengarelli, who knew Etruria sowell, their mode of construction was distinctly unusual; yet (regrettably) he gave no further factual details, only indulging in speculative comparisons with Halstatt tumulus-construction in Côte d'Or<sup>2</sup> and Bohemia. The details revealed from the air confirm that the Colle Pantano cemetery is an abnormally interesting and important site. It is all the more sad, therefore, to record that within the last year or so it has been severely damaged. State schemes for land-improvement (the '*Ente Maremma*') are having a sweeping effect all down this coast. 'Deep-ploughing' and mechanical 'graders' have spread and erased many of the tumulus mounds on the south ridge at Colle Pantano, while new settlers' farms are being built on the north ridge and their vineyards and plantations will soon obscure the tumuli. It will never again be possible to obtain such clear aerial plans as those shown on Plate 33, which are enlargements from verticals having an original scale of 1 : 9,600.

At least forty large soil-marks can be identified and some of these form a composite cluster of two or three smaller ones, so that it is evident that over fifty independent structures are represented. The resemblance to the ploughed-out tumuli at Monterozzi is very striking. But those at Colle Pantano are more scattered as there was not the same pressure on available space, and they appear more obvious because the colour-contrast with the surrounding earth is in itself more extreme. Some of them deserve special comment.

Ploughing has tended to spread widely the white pieces of gypsum which cause the soil-marks, and it is difficult therefore to trace the exact outline of the buried tomb-structures below. But it is of special interest that the soil-marks of some of them seem to show a straight side (possibly even a sub-rectangular shape); for instance No. 40, Nos. 21-23, and No. 32 (*c.* 150 feet long).

<sup>1</sup> These soil-marks are naturally remarkably clear at ground level, for the circumstances are unique. Where the tumulus mounds stood the surface is covered by shining white lumps and flakes of fine-grained granular gypsum (a soft rock resembling alabaster; an easy, if unusual, substance in which to excavate the ditches, etc., of tumuli!). Specimens which I collected on the spot have been examined by the Department of Geology in the University of Oxford. This rock can occur as layers many feet in thickness.

<sup>2</sup> Professor Hawkes tells me that this cannot be earlier than *c.* 675 B.C., and consequently cannot be used to support the *pre-Etruscan* origin of the Colle Pantano tumuli which was suggested by Mengarelli. Systematic excavations here would probably hold many surprises; but this necropolis (so close to the sea) might prove to contain some early forms of Etruscan tumulus-construction.



To illustrate the value of 'Comparative Coverage', i.e. photographs taken at different dates, I have placed together on Plate 33 two aerial views of the centre of the site in the spring of 1943 and 1944. Comparisons of this kind are most important in the study of Etruscan cemeteries, particularly when the evidence consists of soil-marks. For the condition of the surface soil, ploughing, etc., is never exactly the same from year to year, causing minor variations in the appearance of the archaeological features. In both years the markings recorded the same outlines of structures in the same positions, but with some interesting and informative differences in detail (e.g. to No. 32). For some markings the photo of 1943 is the more useful, for others that of 1944. It was especially helpful to be able to compare the two pictures when examining the course of a buried 'cemetery road'. This was bordered by tumulus markings, and is visible as a line of darker tone (due to its depth of silted soil, un-mixed with tumulus debris) between Nos. 9 and 26. Part of its course was made clear by a tumulus alignment in 1943; in the next year this sector was more difficult to recognise but the continuation of the road was clearer. It is a good example of photographs complementary to one another.

In many cases a soil-mark evidently represents pairs of tumuli set close together, and in some examples it can be seen to consist of a group of three adjacent structures:—for instance No. 16, composed of circular markings each about 80 feet across, and Nos. 35 and 37 which are similar. Nos. 15 and 18 are particularly clear and appear to represent single structures; the markings measure c. 100 feet across. The best preserved tumulus-mound visible in 1953 was that of No. 29, about 6 feet high; but most were almost, or entirely, levelled. On the ground, I measured the diameter of several of these soil-markings, and, once again, the results confirmed the accuracy of measurements calculated directly from the air photographs,—provided that they are made with care. At first glance it may seem that there is more variety than similarity in the shapes of the markings, but the practised eye will be able to distinguish the indications of circular structures which they exhibit. The blurred outline, natural to soil-marks, over-emphasises apparent differences, and we must also guard against its tendency to give an exaggerated impression of the real size of the structures beneath.<sup>1</sup> However, here, they can scarcely represent ordinary *tumuletti arcaici*, which produce much smaller soil-marks than these. Their construction and precise date present a very interesting problem of an unusual kind, which only systematic excavation (guided by the air photographs) can decide. Some air photographs show clearly a parallel alignment, presumably along a buried cemetery road with Nos. 7, 9, 10-12 and 14 on one side and Nos. 8, 4 and 13 on the other.

<sup>1</sup> Even when these photographs were taken, 12 years ago, ordinary (not 'deep') ploughing had often spread the debris of the mound beyond the true architectural edge of the buried tumulus structure; in some of these surface soil-marks this has caused a kind of penumbra, or outer ring, round the (whiter) outline which in many cases can be distinguished inside.





37. TARQUINIA, MONTEROZZI. An enlargement of part of Plate 36, giving a detailed view of the part of the Etruscan cemetery near Secondi Archi (medieval aqueduct) which can be seen on the left. The soil-marks show hundreds of levelled tumuli, some being in alignment and indicating buried cemetery roads. See p. 136 and Fig. 10. *Crown Copyright Reserved.*





## CONCLUSION

It must be re-emphasised that the air photographs illustrated were not taken for archaeological purposes, although they have led to important discoveries. One should consider how great could be the value of the results obtainable by a carefully planned air reconnaissance, executed or directed by those skilled in its use.

The site-plans of Banditaccia, Monte Abetone and Monterozzi which I have prepared are therefore provisional, in the sense that further photographs (if properly taken) will undoubtedly reveal additional tumuli. Nor have I had time as yet to compare each and every single crop- or soil-marking seen on the photographs with its corresponding traces on the ground, as ought to be done eventually. I have checked many. But additional ground-checks could further improve the plans in detail.

In recording these tumulus-markings on the plans I have, throughout, taken a conservative and cautious view, as regards their number and also their size. But some of the smaller ones (e.g. on the Monterozzi), which are clear enough on the original photographs, may be less obvious on a half-tone plate. This, however, is no reason for omitting them from the plan, for a slight loss of detail is considered inevitable in reproductions. As with others studies, one must go back to the original documents for the finer points of analysis. In dealing with the soil-markings at Monterozzi and at Colle Pantano it was occasionally difficult to separate individual structures, when a group of these were evidently closely packed together, and I have indicated the approximate area covered. Some such markings probably indicate, or include, various architectural forms of tomb structures other than tumuli (e.g. free-standing *tombe a camera*). Here and there, as for example west of Arcatelle at Tarquinia (Fig. 10), there are undoubted indications of large numbers of tumuli which are not sufficiently clear for me to mark singly, even though two cemetery roads can be traced through them. In such a case I have, for the present, been content to record their presence by a conventional symbol of stippling.

Last of all, a word must be said about the scales of my site-plans, and the measurements taken from them. The scales have been calculated with the greatest care to ensure accuracy, and those markings whose dimensions have been given in this chapter were measured to 0.1 of a millimetre on the photographs. Three different standard methods of determining the scales were used, as a check on one another. (i) By comparing the distance between two points on the photograph and on the relevant map-sheet. (ii) By photographic data:—i.e., the formula relating flying-height of aircraft and focal length of camera lens. (iii) By comparing the measurements of an object of known size on the ground and on the photograph.

Very accurate results were obtained. One more example must suffice. This combines methods (iii) and (ii). At Cerveteri (Fig. 8), Mengarelli's excavated

Tumulus No. II measures 135 feet in diameter on his published plan in *Studi Etruschi*. Now, on the air photograph which I was studying its image was 5 millimetres across. By comparing these two measurements a scale for the photograph could be obtained by simple proportional mathematics.<sup>1</sup> But this was not all. I already knew that the estimated scale of the photograph was 1 : 8,200, as calculated from flying height and focal length. To confirm this scale, I used photogrammetric tables for quick reckoning, and the measurement of 5 mm. at a scale of 1 : 8,200 independently gave the figure of 134½ feet for the diameter of this tumulus, from air photographic calculation alone! This precise agreement between the two measurements, obtained on the ground and from the air, thus confirmed the scale of 1 : 8,200 for the whole photograph as estimated by method (ii), and an accurate map with the same known scale could therefore be traced from it.

#### POSTSCRIPT

I must add a brief note on a very important sequel to these discoveries. In 1956 the Fondazione C. M. Lerici invited me to take part in the field-direction of a revolutionary method of investigating buried Etruscan tomb-chambers, and the work has been continued since then.

The results confirmed my air photo interpretation of levelled tumuli at Tarquinia, Monte Abetone (Abbatone), etc. The technique, originated by the Fondazione Lerici, has now been proved to be of great value. First, air photos and resistivity survey locate a suitable site. Next, an electric drill (powered by a generator) bores through the natural rock (tufo) to the calculated position of the tomb-chamber. When its roof is pierced, a long metal tube containing a camera with flash apparatus is inserted and rotated. 12 photos at intervals of 30 degrees give a total panorama, and show the position of the entrance and whether the tomb contains grave-goods or has wall-paintings. Tombs which still contain 6th-7th century B.C. pottery have been found by this method. At Monte Abetone as many as 40 tombs were examined in 12 days!

<sup>1</sup> For such a proportional calculation any large building or finite line will do, provided it is also clear on the photograph. When engaged in ground-checking vertical photographs, it is advisable to measure several such objects before leaving the site, as a control for photographic measurements of archaeological features, which will be needed in the course of later study.



## CHAPTER IV

# ROMAN CENTURIATION : A PLANNED LANDSCAPE

*Introduction 145, Un-centuriated Systems Contrasted 146, Centuriation: Theory and Practice 148, Topographical Study and Air Survey 155, North Italy: Cesena, Internal Structure of the System 156, Altinum and its Neighbours 166, Tricesimo and Aquileia 170, Istria and Dalmatia: Pola 175, Zara and Ugljan 178, Salona and Hvar 183, Tunisia 193: North 197, Centre-South 200, France: Valence and Orange 207, Conclusion; Varieties of Limitatio 211.*

### INTRODUCTION

TURN now to illustrate a highly individual type of landscape formed by the Roman method of land-partition for settling a farming population. The forceful imprint of the elaborate gridded road-systems which betoken it can still be traced across some thousands of square miles on both sides of the central Mediterranean. In origin, most of these systems were carved out of territories raw from conquest, and even now, in retrospect, their appearance deeply stirs the imagination,—so boldly artificial was the conception and drastic the creation as compared with any earlier man-made landscape in this region.

Reviewing the Roman world as a whole, one could list a variety of occasions when survey and sub-division on some regular principle were applied to lands of differing status, held under tenures of several kinds (p. 214). But this chapter will deal chiefly with the most distinctive category,—the *ager centuriatus* or *limitatus* which was assigned to a newly established community and from which blocks of land were distributed to the settlers according to a fixed scale of allotment. Centuriation was a characteristic accompaniment of those important foundations that were given the status of a *colonia*, although by no means all of them can today show us traces of its use. Notably in Italy, it was applied also to the territory of some townships of other status, *municipia* or even *fora*,—and, where preserved, the extant remains of their gridded systems show no essential difference<sup>1</sup> from those round adjacent *coloniae*. The component-unit most commonly used by the Roman surveyors as the basis of the grid was a convenient square (the *centuria quadrata*) with a side of 20 *actus* (776 yards, 710 metres) and an area of 200 *jugera*. Reference to Plate 48 will show a close-up view of a good specimen, in the famous system that survives in the modern landscape round

<sup>1</sup> See for example the system at *Caesena*, a *municipium*, or round the adjacent *Forum Popili* (Plate 38 and p. 156 seq.).

Carthage in Tunisia. At the start, let us keep in mind this clear-cut image,—albeit one of deceptive simplicity.

Centuriation was never intended to provide the general setting for farming in Roman lands. It was essentially a specialised measure appropriate to particular Acts of State (p. 153) and certain administrative circumstances (p. 214), and not for every Tom, Dick or Harry among provincial communities. *Ab origine* the method was most at home at the heart of the Roman world in the Mediterranean, physically suited to the plains or bare ground there, but (seemingly) it did not lend itself so well to employment in the wooded conditions of northern Europe and the Balkans. On this latter point, considerable care is needed. The slight remains of the Roman centuriated landscape found at Valence, to be described (p. 207), give a valuable illustration of how nearly a large system can disappear,—and *ipso facto* another might become completely untraceable. There were many territories too which had their own well-established agricultural layout prior to Romanisation and to re-shape them would have been a waste of time when more urgent tasks were waiting.

#### UN-CENTURIATED SYSTEMS CONTRASTED

The regimented planning of centuriation can best be appreciated when compared with the loose layout of the *non*-centuriated landscapes farmed under Roman rule. For a comprehensive picture of the latter in tangible form it so happens that we must look to discoveries made at opposite ends of the Empire,—a situation which has at least the accidental advantage of illustrating the extremes of contrast in land-use,—from England,<sup>1</sup> North Africa<sup>2</sup> and Syria. That air archaeology has played a paramount part in finding, mapping and co-ordinating these remains of non-centuriated cultivation needs no further emphasis. The logical basis of *their* layout came from within, shaped by customary methods of agriculture, terrain and climate, local enterprise and 'rule of thumb'. We can very well see these factors in operation in the patchwork of small corn-plots which formed the Romano-British landscape on the downland in the south and on the wolds in Yorkshire. In shape and arrangement they are indistinguishable from those cultivated in the Iron Age, and show no marked difference from blocks of lynchetted fields dated to the Late Bronze Age (e.g. in Sussex and Berkshire).<sup>3</sup> There was no break in downland agriculture at the

<sup>1</sup> Cp. references on pp. 8, 37, and for Romano-British fields in the Fenland see also G. W. G. Allen's photos collected in *Discovery from the Air*, where I have analysed them in detail.

<sup>2</sup> Jean Baradez, *Vue aérienne de l'organisation romaine dans le sud-Algérien: Fossatum Africae*, Paris, 1949; cp. especially the fields shown on pp. 15, 167 and 190. Extensive archaeological survey has also given a clear picture of Roman agriculture in Tripolitania and Cyrenaica: e.g. R. G. Goodchild, *Geographical Magazine*, 1952, pp. 70-80, 'Farming in Roman Libya', and pp. 147-56, 'The Decline of Libyan Agriculture'; also *J.R.S.*, 1949, 81 seq.; 1950, 30 seq., and the 'Lepcis Magna' and 'Cyrene' map sheets of the *Tabula Imperii Romani* (publ. by the Society of Antiquaries, London, 1954). For land-utilisation in Syria, see Poidebard as cited above, p. 30.

<sup>3</sup> *Proc. Prehist. Soc.*, 1935, 16; *Oxoniensia*, 1950, pp. 12, 21, and *Proc. Prehist. Soc.*, 1950, 193.



Roman conquest,—indeed it has been shown that some farms were continuously occupied before and after, over a span of centuries.<sup>1</sup> If we compare the great zone of Roman agriculture in the Fenland round the Wash,—as intensively cultivated as Salisbury Plain at this period,—we likewise find a kaleidoscopic pattern of small enclosed fields of all shapes, here crowded between drainage dykes, former stream beds, twisting lanes and small scattered settlements. Naturally the local problem of water-control and drainage did much to shape the irregular layout. In South Algeria also, but for opposite reasons, the water-supply played a determining part in the form taken by the agricultural landscape under Roman rule. Here, blocks of small fields were grouped in clusters round organised water-points (barrages, fogaras and wells) for irrigation, or fitted to the hill slopes to minimise soil wash-off; corn and olives formed their staple crops. Reinforcing aerial survey by fieldwork Colonel Baradez was able to put his finger on the smallest details, as well as the essentials, of the regional economy. The results give a profound and convincing picture of a settled peasantry on the edge of the Roman world.

It is the comprehensiveness of the factual picture, in visible detail, that makes these examples of non-centuriated Roman land-use of such unique value, for the evidence is spread over some millions of acres. Unfortunately, continental Europe cannot yet produce for comparison remains which are equally integrated. One area with possibilities is the Vosges where there are traces of field walls and terracing<sup>2</sup> on the hillsides that were in use in Roman times. Air archaeology could guide fieldwork in the thorough mapping that is needed. There are 'highland' and marginal zones which would reward search, notably in the foothills surrounding the Alpine regions. Traces of pre-Roman and Roman fields also ought to be recoverable here and there in Spain, especially in hill areas not cultivated now and in the neighbourhood of some forts,—but it seems that none has been reported. To remains of old terracing in Greece, and to the rôle of air archaeology in mapping ancient fields there, we have already referred (p. 29) with examples. Such search is of course normally restricted to the remains of systems of enclosed fields; tangible evidence of other kinds of rural economy,—based on transhumance, ranching, or even 'open field' cultivation let us say,—is much more rare and difficult to find. And if the result of this is to make the bias of our ancient landscapes distinctly one-sided, so too it is influenced by the fact that so many of the European plains have been 'put through the mangle' by strip-cultivation subsequently, with a thoroughness which is most apparent

<sup>1</sup> Cp. C. F. C. Hawkes, reviewing the evidence from General Pitt Rivers's excavations in Cranborne Chase: *Arch. Journ.*, 1947, 27-81. It seems that much of this continuity of agriculture lay in the hands of farms, many or most of which were formerly classified as of 'village' status.

Contemporary and alike in layout, the corn plots in Holland and Denmark are cousin german to our 'Celtic' fields (p. 76 note).

<sup>2</sup> Cp. C. E. Stevens's well-documented account of these features (locally called *rotteln*) in *Revue Archéologique*, IX, 1937, 26-37; and A. Grenier in *Manuel d'Archéologie*, VI, 2, 742. Some areas are forested, but not all.



after aerial study. We have examined (Plate 13 and p. 45) a modern instance from Greece, in actual operation, showing how quickly and drastically a new system of thin strip-fields can eliminate a pre-existing pattern of small, irregular, enclosed fields. Rarely can so clear a picture of this metamorphosis and its effect be studied.

For the study of Roman agriculture the archaeological record in Continental Europe is, in brief, both very uneven and very extensive; but with the use of all the sources a broad picture of the relations of Town and Country in the provinces (notably in Gaul) has been established.<sup>1</sup> The mass of data on estates and villas, which were the mainstay of rural economy, is particularly vast, but this chapter does not aim to touch upon that. Even in the case of the villas, however, an important element is lacking for completeness,—namely the accompanying field systems needed for reconstructing a 'working model' of a villa unit; in England a beginning has been made in the search for their fields from the air (p. 84 note).

In these circumstances, the tracing of centuriated systems has an added importance by reason of the geographical gaps it fills. Furthermore, by comparison with less formal systems the regular intervals and straight boundaries used in centuriation naturally make it easier for us to re-assemble a coherent landscape from topographical fragments.

#### CENTURIATION: THEORY AND PRACTICE

It is one of the chief attractions of the subject that history and archaeology can make a joint approach with mutual benefit. This is more than ever needful as the ramifications are wide and growing. However, in the compass of these pages little more than mention can be made of such important aspects as the administrative, fiscal and juridical.

This chapter will review my findings from new data (exclusive of those from Apulia) set against the background of existing studies. However, one observation should be made briefly before beginning. The capacity of this Roman layout for enduring in the living landscape is well known. On the other hand, where it has been totally abandoned its traces may be preserved in a condition that is much more informative archaeologically; in such circumstances the remains of centuriation tell us more than all the systems still preserved by modern use. In two regions only are such conditions known, in parts of Tunisia (p. 194) and in Apulia where *buried* systems have been literally 'un-earthed' by air photography. In particular, these systems in Southern Italy give conditions for a material advance in the study of centuriation, not only because of the new facts and copious details which are clearly seen but primarily because they can be subjected to excavation, with all the incisive evidence which follows from that. One purpose of this chapter is, indeed, to pave the way for the forthcoming publication of a detailed account of all that the Apulian systems revealed when

<sup>1</sup> See C. E. Stevens in *Cambridge Economic History*, vol. i, 1942 and bibliography appended.



examined in the field in 1949-50 (below, pp. 150, 156, 211, n. 3; and *Antiquity*, 1949, 1950).

In the last century of the Republic and in the first of the Empire, few things better display the arbitrary but methodical qualities in Roman administration than the practice of *Centuriatio*.<sup>1</sup> With an absolute self-assurance and great technical competence, the same formal topographical framework of land-division was superimposed on the well-watered alluvium of the Po Valley and the near-desert of Tunisia, in a nicely balanced blend of the doctrinaire and opportunist. It will be readily recalled that in the Central Mediterranean region, wherever continuity of cultivation was not over-violently disturbed, this system often survived (in skeleton form) to establish itself usefully and thus successfully in the present field- and road-pattern. And it can be accepted as natural that a method so elaborately artificial is likely to be easily comprehensible in some of its aspects and obscure in others.

The principles, at least, are clearly understood. The structural foundation of the chess-board grid of *centuriae*<sup>2</sup> lay in the two primary roads (serving also as base lines for setting out the remainder) which intersected at right angles, dividing the area in four portions; these two were termed the *Decumanus Maximus* and the *Cardo Maximus* with a recommended width of 40 and 20 Roman ft. In Tunisia, an extreme case, they could be planned with reference to a whole province, or in a small colony like *Iader* (Zara) their length would be a few miles only.

Hyginus Gromaticus mentions that as far as possible they should start from a point of origin within the town itself, but failing this they should be placed as near to it as possible. Much has been written about their orientation. But it comes to this: the extant systems show that the theoretically desirable often gave way, on the ground, to the convenient and practicable. With the practical temper of the Roman mind it would have been surprising if this had not become the case. Thus, the recommended siting of the *Decumanus Maximus* in coincidence with the sun's passage from east to west, and of the *Cardo Maximus* from north

<sup>1</sup> Fabricius in his article on *Limitatio* in Pauly-Wissowa, *Real-Encyclopädie*, summarised the extensive literature up to 1927; see also *ibid.* (1894), *Ager, Agrimensores*. Later references will be found in Prof. Fraccaro's notable studies which are particularly helpful:—'La centuriazione romana dell'agro Pisano', in *Studi Etruschi*, XIII, 1939; 'Centuriazione romana dell'agro Ticinese', in *Atti e Memorie del Quarto Congresso Storico Lombardo*, 1940; 'Intorno ai confini e alla centuriazione degli agri di Patavium e di Acelum', in *Studi di Antichità Classica offerti a Emanuele Ciaceri*, 1940; 'La colonia romana di Eporadia (Ivrea) e la sua centuriazione', in *Annali dei Lavori Pubblici*, 1941; also his article 'Agrimensura' in *Enciclopedia Italiana*.

There is no definitive book in English on centuriation.

<sup>2</sup> Ancient tradition stated that the unit used by Romulus in land-distribution to the Romans was the *heredium* (equal to 2 *iugera* in area). The *iugerum* was the area that supposedly was ploughed by a man with two oxen in one day. Its area was equal to 2 × 1 *actus* (240 × 120 Roman feet), i.e. about  $\frac{2}{3}$  of an acre or  $\frac{1}{4}$  of a hectare.

The size of the *centuria* is also expressed in terms of units of length, i.e. the *actus* which was 120 Roman feet long (116.496 English feet). Thus, the ordinary *centuria*, 2,400 Roman feet long each side, can be described as measuring 20 × 20 *actus* (776 × 776 yards).

So, in practice, when working with air photographs and maps on the structure of *centuriae* and their internal sub-divisions, one is always on the watch for linear measurements that approximately form multiples of 116 English feet.



to south, could in practice be modified<sup>1</sup> to suit terrain, pre-existing main roads and other considerations, as Frontinus and Hyginus admit. The system at Zara (Fig. 16) was aligned north-west to south-east deliberately, in harmony with the direction of the physical features of the Dalmatian coast. The alignment of the system round Salona was similarly adjusted. Having set out the two axial lines the surveyors proceeded to lay down secondary roads, set at regular intervals (commonly of 2,400 Roman feet), which formed the boundaries of the *centuriae* and gave public access to them. The points of intersection were marked with boundary stones (*termini*), inscribed or plain. Every fifth road from the centre of the system, formed one of the *limites quintarii*, with an allowance of 12 Roman feet for its width,—while theoretically no more than 8 Roman feet were set aside for each of the intermediate roads (*limites linearii*). Thus the manuals of the Roman surveyors (*gromatici*, *agrimensores*) prescribed in model terms, but we should remember how changeable is the relation of the text-book model to living practice, in everyday life. Many years ago Schulten urged the need to corroborate such details by excavation. In 1945 air photography in Apulia showed innumerable examples of the *limites linearii*;—buried, but defined by the crop-mark above the ditch each side of the road. When measured from the vertical photographs a width of 12 to 15 English feet was found to be common, with ditches *c.* 4 feet wide. We have since excavated a number of sections across them.

The *gromatici* tell us that the roads were bordered by ditches, trees, hedges, etc., but the same sources make it clear that these boundaries were a frequent source of litigious disputes. Where they have been laid out across hilly or difficult ground they have often been abandoned later for tracks that followed the natural features more suited to peasant convenience. In some areas the sets of parallel *cardines* and *decumani* are both equally clear, but it is also noticeable that the lines of one axis are often much better preserved than those of the other. Occasionally, *centuriae* were deliberately left incomplete, and this must be taken into account when considering the mountainous fringes of the systems in Dalmatia. It is natural that there should often be incomplete *centuriae* along the edge, because the outermost *limites* did not usually coincide with the boundary line (*finis*) round the colonial *territorium*. These fragments were termed *subsecivae*,<sup>2</sup> and the name was also acquired by those completed *centuriae* which could not be completely parcelled out internally because of unsuitable terrain (*loca inculta*).

<sup>1</sup> There were also a few unorthodox exceptions, e.g. in the *ager Campanus* round Capua, *ubi est kardo in orientem et decumanus in meridianum*, a complete reversal of the normal, the *cardo* here running eastwards and the *decumanus* southwards. This kind of thing, the *agrimensor* Frontinus seems to say, is *contra sanam rationem*! Cp. Pais, *Storia della Colonizzazione di Roma Antica*, 1923, 301.

It is important to note that only documentary or epigraphic evidence permits a definite statement of which were the *cardines* and which the *decumani*. Even then difficulties and differences of opinion can occur,—instances from Tunisia are quoted below (p. 198). In the absence of special evidence, roads which ran from north-west to south-east (as at Zara and Salona) are conventionally termed *cardines*.

<sup>2</sup> For an example see Plate 49 and p. 202.



The *centuriae* most frequently encountered round *coloniae* are those of  $20 \times 20$  *actus*. There are examples at Pisa, Florence and Capua; in the Po Valley at Ivrea (*Eporedia*), Pavia, Parma, Padova, Bologna and Cesena; in the Veneto, south of Bassano; at Pola in Istria; at Zara and Salona in Dalmatia; at Carthage, and elsewhere. Most of those to be illustrated in this chapter are of this type. But interesting variations are known, where the size of the basic unit has been adjusted in accordance with the area of the *ager centuriatus*, or the quality of the land, the type of recipient, and so forth. We shall return to this point when examining Plate 39 which shows two adjoining systems, each based on a unit of a different size; others to be illustrated are the  $12 \times 12$  *actus* units in north-east Italy (p. 170) and those measuring  $5 \times 5$  *actus* recently found on the island of Hvar (Lesina) in the Adriatic (p. 191). Such variety in the shape and size of the basic unit of the grid is much more common in the case of the earlier systems. But by the time we reach the Empire the  $20 \times 20$  *actus* square had become the regular choice,—in area a true *centuria*.

The professional views of a modern surveyor regarding the technical side of Roman methods are of interest: and a study on these lines was made by De Caterini.<sup>1</sup> He summarises and illustrates clearly the facts known about the instruments used by

Roman surveyors in the field, especially the *gnomon* as a compass and the *groma* as a surveyor's cross-staff. Fig. 12 shows how the latter was used. The *groma* actually found at Pompeii in 1912, during the excavations in the 'taberna officina' and house of the *ensor* Verus, was described by Della Corte (*Monumenti Antichi*, vol. xxviii). These accounts have rendered obsolete the earlier hypotheses about the *groma*, which was a simple but effective instrument for determining all gridded lay-outs. A representation of the instruments used by the profession is given on the notable funeral inscription at Ivrea in North Italy, dedicated to a *ensor*, Lucius Aebutius Faustus. In passing, we may

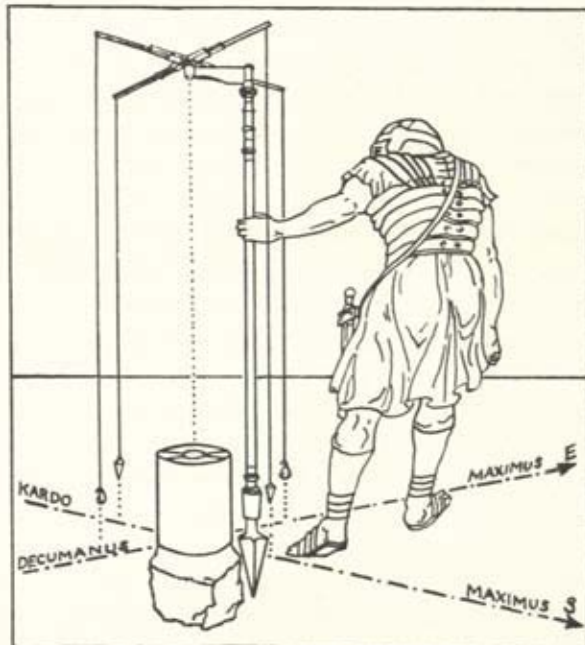


FIG. 12 The Roman surveyor's *groma* (cross-staff) used for laying-out lines at right-angles 'in the field' (after Frigerio, *Antichi strumenti tecnici*.) See p. 151.

<sup>1</sup> See 'Gromatici Veteres:—I tecnici erariali dell'antica Roma', in *Revista del Catasto e dei Servizi Tecnici Erariali*, 1935, pp. 261-358. I have to thank Prof. Fraccaro for a copy of this publication.



note that a 'line', in the surveyor's sense, was termed a *rigor*. This was set out with surveyors' poles, *metae* or *signa*,—sighted until they were in a straight line and hidden behind each other (*consumebant*). To 'sight a line' visually was *conspicere* or *perspicere*. Then with the cross staff, the *groma*, the laying-out of right-angles for the grid could begin. One could fill a volume with a discussion of a long list of technicalities and experts' terminology (lapsing into professional jargon) found in the 'field-manuals' of the gromatic writers.<sup>1</sup> Niebuhr considered these texts to be among the most difficult in all Roman literature, yet their mysteries exercise a strong attraction. Thus Brugi declared: 'Nella solitudine del mio studio niun libro me fé provare tante emozioni come la collezione dei gromatici'.<sup>2</sup> Although much of the detail is explicit or at least sufficiently circumstantial, the sense of many passages has defied a clear rendering and the cumulative effect produces very heavy going. From time to time it is hard to escape the feeling that the *gromatici*, at least in their writings, were specialists who occasionally like to make their craft something of a 'mystery' (in both medieval and modern senses of the word). While there may be an element of truth in this view, the impression is partly due to the late forms in which these writings have survived.<sup>3</sup> By contrast, the gridded centuriated landscape *as we see it today*, conveys an impression of business-like efficiency, both in execution and intention. But what happened inside the neat text-book *centuriæ* after several generations of use? In Apulia we are enquiring into such matters by direct observation of the remains.

A word must be said about one feature of special interest in the manuals of the Roman surveyors, in the form in which we have them today. They were illustrated with numerous small explanatory drawings,<sup>4</sup> in the text, of model centuriated landscapes and diagrams of methods. On a future occasion I shall compare some of these 'black-board' sketches with factual details found in systems that we can see and excavate (e.g. in Apulia). There is a great deal more that can still be extracted from these professional diagrams by such an analysis, although many are disappointingly enigmatic. The latest study<sup>5</sup> of those among them which aim to show the layout of *coloniae*, surrounded by their centuriated landscapes, has usefully demonstrated that only one or two pictures have any

<sup>1</sup> Blume, Lachmann, Rudorff, *Die Schriften der römischer Feldmesser* (vol. I, texts; vol. II, commentaries) 1848-52. There is also a revised but incomplete edition by Thulin, *Corpus Agrimensorum Romanorum*, Leipzig, 1913. Originating from the early Empire we have works by Frontinus and Hyginus. In some ways still more interesting are the passages from Siculus Flaccus and Aggenius Urbicus. The *mensores* developed their own official hierarchy of grades and specialisations: at the time of Constantine they were organised in an 'office' under a *primicerius mensurum*. Their abilities were also used in related matters of administration.

<sup>2</sup> *Le dottrine giuridiche degli agrimensori romani*, 1897.

<sup>3</sup> Even the earliest version does not antedate 450 A.D. and is probably 6th century, being a re-editing (with some interpolations) of work dating mainly from good imperial days; the later versions are thought to be mid-9th century, and have many interpolations (cp. Thulin, *Die Handschriften des Corpus Agrimensorum Romanorum*, 1911).

<sup>4</sup> The best reproductions of them are those published by Thulin, *loc. cit.*, 1913.

<sup>5</sup> F. Castagnoli, 'Le forme delle colonie romane e le miniature dei codici dei gromatici', in *Atti della Reale Accademia d'Italia*, vol. IV, 1943, 83-118.



precise topographical information to give us about individual systems as they existed. Most illustrations were drawn primarily to emphasise didactic points in the text, using real systems as a basis, but without much attempt at accuracy in map-making. Several are purely imaginary exercises, to show what a really fine system *might* look like 'in the field', in the manner of a sand-table 'battle' in a military staff college today.

The practice of centuriation is, of course, linked with many crucial epochs in land ownership and utilisation during the Republic and early Empire. One has only to think of the conquest of Italy and the foundation of strategic Latin colonies, or peasant land-hunger and the Gracchan reforms, the problems of settling veterans especially under Augustus after the Civil Wars, or the recurrent tendency for the colonial small farmer to be swallowed up by the large estates, *latifundia*. For their bearing on these matters, the discovery and dating of centuriated systems by field archaeology, and particularly the excavation of their farms and holdings, constitute work of direct historical value.

The creation of such systems as those considered in this chapter was essentially a formal Act of State, fortified by sanctions from religion and custom. The force of the foundation ceremonial was still powerful, mensuration was still hallowed by divine authority and stereotyped by secular practice. But, while its basic principles had a natural rigidity, centuriation was made to be used; and when we encounter local variations between systems we need not feel surprise at the business-like use of a venerable method. As for the roads outlining the centurial squares, we may liken them to picture frames,—many differing compositions are possible inside. And it is the picture (when decipherable) more than the frame which archaeology now needs.

One factor which undoubtedly helped to give long life to these systems was their convenience for various purposes of administration; in Africa under Diocletian (and much later still) the *centuria* was employed in assessing tax and thus was linked with one of the most enduring institutions in civilisations, the collector of taxes.

In writing of centuriation Man is usually crowded out by Topography. The reader is urged to remember, throughout this chapter, the human realities:—the peoples dispossessed, the new settlers far from home, the solemn foundation (*deductio*) of the colony, the rigours of breaking-in much untamed ground, the social ferment of success and failure. It is unlikely that daily life was any less vigorous and highly coloured than has been normal in early phases of colonial settlement since then. The episodes in the foundation of a colony and *ager centuriatus* at *Placentia* (Piacenza) give a good picture of the vicissitudes and hazards that might be encountered (p. 262). From the practical view of the farmer there is still much that we would wish to know about the agricultural working of centuriated systems, apart from their use as instruments of State policy in land-settlement. In the Po Valley the centurial grid, and especially its regular internal subdivisions, ensured (as no other arrangement could) the



systematic provision of many ditches which would drain water in the heavy winter rains, so that autumn-sown seed did not lie in sodden soil, and could germinate properly; and the same ditches would allow the water to be well distributed and economically conserved in the dry summer. Along these ditches 'shade-trees' would flourish as today,—reducing scorching in the fields between. Fundamentally, centuriation broke up the landscape into manageable parcels of land and facilitated large-scale gardening,—still the basis of most modern Mediterranean cultivation. In Tunisia, centuriation aided the intensive 'dry-farming' required by the environment and rainfall; and, with its many field-boundary banks and ditches, helped to preserve the precious layer of topsoil from surface erosion. We shall return presently to these points (pp. 201 and 203).

Such a purposefully regular dissection of land for cultivation was not again matched in formal precision until comparatively recent times: e.g. in the settlement of North America or in the systematisation of the Great Alföld after the Ottoman tide had receded from Hungary in the 18th century. Students of centuriation will find it of interest, as Schulten long ago observed, to examine briefly some details of living systems constructed on analogous principles. Good examples can be seen on the wheat-lands of the Canadian prairies, partitioned into squares (called 'sections') by regular grids of roads; and the large-scale maps which show the environs of Regina, the capital of its province, can be recommended.<sup>1</sup> When the Canadian Pacific railway was completed in 1885 this territory was little settled, and a new town was needed, on this line of communication, as a place of government and centre for stationing the mounted police to control the Indian tribes. Physically, Regina stands like a *colonia* in its *ager centuriatus*; the grid of roads is in units one mile square, and inside them are farms and regular field boundaries. The point of origin of the grid, which lay just outside the town, is still recorded on the map; and it is also interesting to note the small deviations that developed in the formal road pattern, and the reasons.

One practical point deserves emphasis. It is advisable to remember that the layout of *bonificazione* in Italy, and land-reclamation schemes of the recent past in Europe generally, may superficially suggest an appearance of antiquity that can prove deceptive.<sup>2</sup> An examination of large-scale maps, or a series of vertical air photos, should remove all danger of confusion. A watchful eye is needed to eliminate the crop-markings caused by levelled ditches which were dug during the early stages in these modern systems,—especially in Central Europe, where any remains of true centuriation are likely to be vestigial now,—and also to

<sup>1</sup> Sheet 73 L/2 East Half, 1 : 50,000 (publ. by Dept. of Mines and Surveys, Ottawa). For the early townships, G. Taylor, *Canada*, 2nd ed., 1950; some of those laid out by the British were given a territory of c. 10 × 10 miles, which was gridded; several were colonised by veteran soldiers who had fought on the British side in the American Revolution, e.g. by the Regiment of New York which moved to Upper Canada in 1784. For air views of modern gridded systems: *Geogr. Review*, 1942, 366; *ibid.*, 1939, 561.

<sup>2</sup> As in the case of certain areas south of Rome: see Lugli, *Saggi di Esplorazione Archeologica a mezzo di Fotografia Aerea* (Istituto di Studi Romani, Roma) 1939, tav. VII, VIII. These are recent regularised field-boundaries, not *centuriae*. Those on tav. VIIIb take their alignments from the railway line, a few miles north of the model village of Aprilia (sheet 158/IV. N.E.).



distinguish (as far as is possible) those straight boundaries of pseudo-centuriation which have grown up inside genuine systems preserved by use.<sup>1</sup> In short, the topographical study of centuriation requires attention to the *growth* of the landscape, including the most recent developments.

### TOPOGRAPHICAL STUDY AND AIR SURVEY

Naturally such large units as *centuriae* will only survive imperfectly above ground, with gaps and distortions in the straight lines of the Roman roads. On the other hand, the skeletal structure of a system, even when poorly preserved, will usually emerge distinctly from the heterogeneous details of the modern landscape when seen from the air. In those systems where Roman roads and boundaries have continued in use to the present day, topographical study can do little more than articulate the fragments of the skeleton, whose remains may be vestigial. So far it is only in the systems which went out of use in Apulia and Tunisia that we have remains 'in the round' so to say, which can be dealt with three-dimensionally and dissected by excavation.

Air photographs have in this subject their customary dual rôle; to demonstrate the known and to discover the unknown. Let us consider the first. On the ground it is scarcely possible to obtain comprehensive or effective photographs of systems as a whole (cp. Plate 38), but the air-camera is in a position to record, impartially, *all* topographical features on the surface. Even on large-scale maps, place-names and symbols restrict the space available for inserting field-boundaries and details of terrain; and an appreciable element of selection is necessarily introduced. 'Total' mapping with vertical photos is not subject to this limitation.<sup>2</sup> Indeed I remember an occasion in the last war when they were torn up in disgust because they showed details which the map did not! With the full array of walls, hedges, and other minor boundaries, we are equipped with a more complete range of facts than is ordinarily provided by ground survey. Such small details of the landscape, though seemingly of little importance, were often surprisingly stable and resistant to change;—they prove of the greatest value in filling gaps in the less well-preserved areas of centuriation, and still more usefully, give indications of former internal sub-divisions within the *centuriae*. Some years back Professor Fraccaro forecast that the period of discovery and active study which followed the arrival of more accurate maps in the middle 19th century would be matched by a similar phase when full use could be made of the aerial view.<sup>3</sup> This has proved correct. At Florence, Pola, Cesena, south-west of the Treviso, and elsewhere, systems known for many years have yielded additional information.

<sup>1</sup> Cp. 'Sources of Error', p. 48; also pp. 161 and 169.

<sup>2</sup> E.g. in 1956 I mapped large areas of centuriation round Cuneo, Tortona, Voghera, Lodi, etc.

<sup>3</sup> 'I progressi della cartografia ebbero sotto questo aspetto un' importanza paragonabile a quella che oggi ha assunto per le indagini di topografia storica l'esplorazione dall'aeroplano, ma non furono sufficientemente sfruttati', *Studi di Antichità Classica offerti a Emanuel Ciaceri*, 1940.



In addition to assisting the closer study of the 'comparative anatomy' of systems that are already known, air photography can reveal others for the first time, given suitable conditions.<sup>1</sup> Zara and Salona have provided good examples of discovery, made apparent by surviving traces of the *centuriae* in the layout of modern roads and field-boundaries. They have remained unknown until now because of the poor quality of the large-scale maps. This factor is still a handicap in the study of some Mediterranean countries today, although as the result of the last war most now have a series of 1 : 50,000 scale maps that have been revised from air photographs to some degree. Two other discoveries, here described for the first time, are the systems of *limitatio* on the islands of Ugljan and Hvar (Lesina) in the Adriatic, which illustrate the Romanisation of the Dalmatian coast; another aerial discovery is the system at Valence, the first to be traced in France. With the help of air archaeology we now know more, too, about the large but still enigmatic system which belonged to Aquileia, and about that near Altinum. The study of centuriation in Tunisia has been carried many stages further by the same method. In all these cases the evidence survived above ground in one form or another, and awaited total mapping.

But, as has been said, we are faced with a radically new situation in Apulia, where *all* the evidence comes from *buried* systems which had utterly vanished. A detailed account of the excavations and fieldwork carried out in 1949-50 with the generous support of societies and committees in England (see pp. 86 and 93), is to be published in a Report of the Research Committee of the Society of Antiquaries. This is in preparation and it would not be proper to anticipate its findings here. Preliminary descriptions can, however, be found in my articles in *Antiquity*, June 1949, and June 1950, with air and ground photographs of the centuriated roads, and associated farms and cultivation patterns, which have been traced by their crop-mark outlines over very many square miles. They are identifiable on the ground as well as from the air, at appropriate seasons, through the different growth of vegetation above them. But without the air photographs as a guide to their position I doubt whether their existence would ever have been recognised. As it is, we are faced with a startling variety of agricultural *minutiae*, opening remarkable prospects of excavation which have already been successfully put to the test in 1949 and 1950. As a result, a new and fundamental stage for the study of this form of Romanised landscape has been reached: for we have begun to determine empirically, by direct examination, many points which are in doubt in the accounts of classical writers.

#### CESENA: INTERNAL STRUCTURE OF THE SYSTEM

The first and fundamental impression that we receive from the systems spread across North Italy is the magnitude of the conception that inspired their con-

<sup>1</sup> Some of the following discoveries were described briefly in my preliminary article, 'A technique for the study of Centuriation', in *Antiquity*, 1947. The remainder were outlined in papers given in 1954 at the meetings of the International Classical Congress at Copenhagen and the British Association in Oxford.



struction, and the blend of ambition and stubborn capability in matters of detail that could give effect to it. Virtually it would have been possible to ride from Turin to Trieste,—a distance of 300 miles from west to east,—within centuriated systems all the way. This landscape was the most homogeneous that the region has ever possessed, and quite as remarkable as any achieved on the larger stage of North Africa. When we proceed to examine its smaller features, the vertical air view adds so much detail to the map that we look at the ground with new eyes.

As an example let us consider Plate 38, taken from a height of 5 miles over the centuriation north-east of Cesena,<sup>1</sup> 15 miles W.N.W. of Rimini. First I shall describe its system in general, mentioning a new addition that can be made to it (p. 159), before discussing the details of the layout in relation to Roman land use. Its road-grid is aligned north-south and east-west, and in this it differs from most of the other early systems<sup>2</sup> flanking the Via Aemilia (built by M. Aemilius Lepidus, consul 187 B.C.), which took this great artery as their base-line, their *decumani* set parallel and their *cardines* at right-angles to it. The effective emergence of the Roman Republic from the peninsula into the northern plain was a turning-point, and the early systems of centuriation are its outward and visible sign;—the tangible embodiment of a confidence to act as a 'great power'.

The precise date of laying the *ager centuriatus* at Cesena is not recorded. But we should set it in the context of what we know<sup>3</sup> of the Romanisation (as *fora*, etc.) of the small pre-existing centres on the line followed by the Via Aemilia (e.g. the market town of *Forum Popili*, next up the road). This would seem to be probably in the period of the second and third quarters of the 2nd century B.C.,—a secondary stage of steady Romanisation in this region, less recorded than the initial, more dramatic phase of the big colonies like *Placentia* (p. 261) and *Bononia*. Polybius describes how thriving was this part of Italy c. 150 B.C. Obviously the rich black alluvium of the valley, when first intensively cultivated on a large scale, would have given wonderful yields.

<sup>1</sup> Originally a pre-Roman tribal centre, with Etruscan occupation, Roman *Caesena* had the status of a *municipium* under the Empire but is very rarely mentioned. The best documented account of its history and centuriated land is given by Mansuelli, *Caesena, Forum Popili, Forum Livi*, 1948 (*Italia Romana: Municipi e Colonie*, series II, vol. iii).

<sup>2</sup> For these see Tenney Frank, *Economic Survey of Ancient Rome*, I, 123, with the available statistics on the number of colonists and size of allotments. For example in 189 B.C. a Latin colony of 3,000 was sent to Bononia (Bologna), and blocks of 50 *jugera* were given to the commons and of 70 to the knights. On the other hand, when Parma and Mutina (Modena) each received a Roman colony of 2,000 citizens in 183 small 'old style' allotments of as little as 8 and 5 *jugera* were distributed; and no more than 10 *jugera* was the standard lot given to colonists at Saturnia in the same year (Livy, 39, 55). Such considerable variations in the colonist's share were due to the differences in the status of the colonies and in the purposes behind their foundation. See E. T. Salmon, *J.R.S.*, 1936, esp. p. 65.

Schulten (*Römische Flurteilung*, pp. 21, 24) shows that the total land distributed at Parma and Mutina, calculating from Livy's figures, would only be a very small percentage of the total area that is demonstrably covered by their centuriated systems. For a possible explanation see page 165, n. 1 below.

<sup>3</sup> Cp. G. Mancini, *Le Colonie ed i Municipi Romani dell'Emilia Orientale*, in *Emilia Romana*, vol. I, 100 seq. (1941).

The orientation used at Cesena was the best for a system that was intended to occupy neatly the triangle of land at the beginning of the *Via Aemilia*, filling the space between the north-south line of the marshy river Savio and the oblique line of the Adriatic seaboard between Rimini and Ravenna (see Fig. 13). The centurial squares are of normal 200 *jugera* area (776 yards square). The irregular lay-out of the non-centuriated field-boundaries in adjoining areas is strongly contrasted.

Starting from the town a straight road (Plate 38, A) runs due north. At first glance this looks as though it were the *Cardo Maximus* of the system. But it is not truly at right angles to the parallel roads that preserve the Roman *decumani* from east to west. It is, it seems, a later replacement of the original Roman road, traces of which (on the correct alignment) fortunately survive

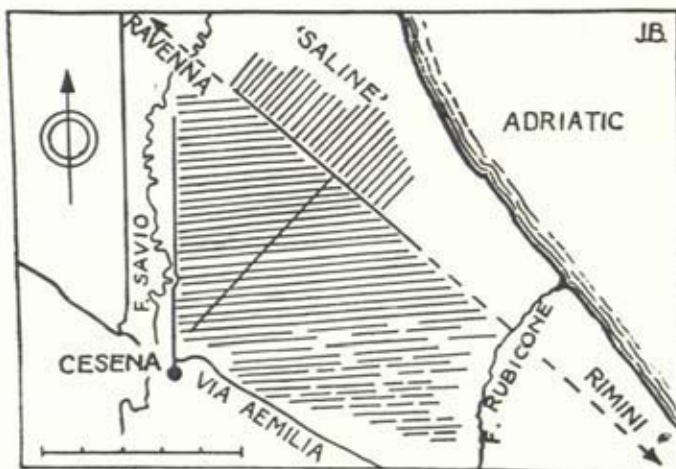


FIG. 13 Areas covered by traces of Roman centuriation at Cesena (N. Italy). The remains on the coast were not fully known. The conventional lines show the orientations of the two layouts but not the individual *limites*. Scale in miles. See Plate 38 and p. 158.

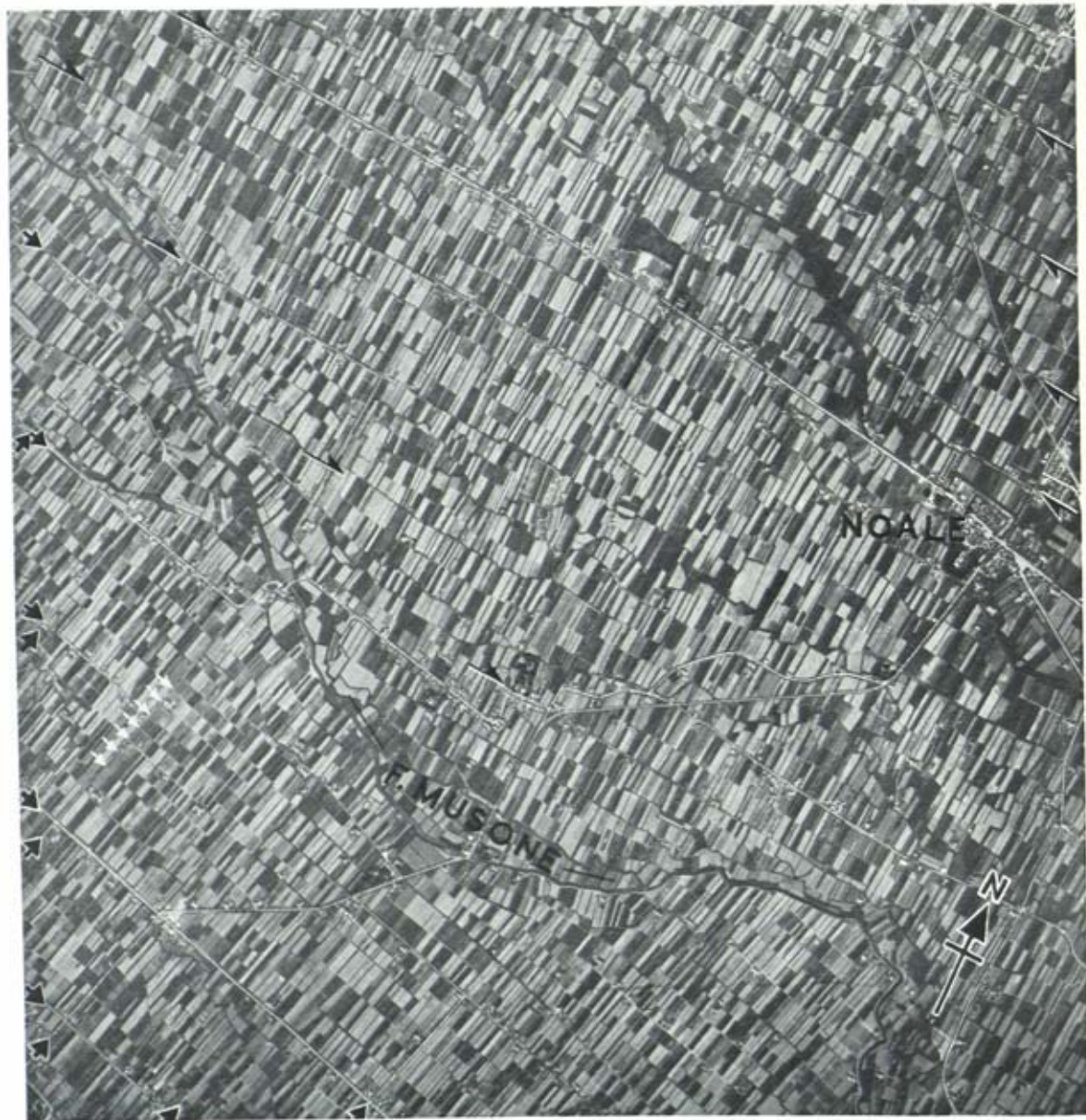
at Borgo Pipa near the northern apex of the system. Presumably the Savio's meandering course bit deeply into the original road, and the line of the successor had to be deflected a little to the right, off the true angle. It can be seen that the Savio has continued to impinge even on the present road, at two points. The *Via Aemilia* (C-D) passes through the town, abandoning its long straight course and bending to avoid the north spurs of the Apennines, which played a prominent part in the closing campaigns of 1944-45. *Curva Cesena* is mentioned in the Antonine Itinerary, and this unusual epithet recalls the conical *rocca* (A) on whose top perched the early Roman town, outlined by the main road that ran round its foot. This kink in the road was part of the irregular arc which the *Via Aemilia* followed to skirt the mountain spurs, before it shot forward like an arrow from a bow up the plain to Piacenza. Its sudden deflection at Cesena impresses all who travel down this monotonously straight line, and the aerial





38. PO VALLEY, CESENA. High-altitude vertical photo, covering an area of  $6 \times 7\frac{1}{2}$  miles, giving a uniquely comprehensive view of existing parallel roads which preserve the Roman grid. The original unit was the square of  $20 \times 20$  *actus* ( $776 \times 776$  yards). A specimen is indicated by a circle. The fields uniformly have their length on the north-south axis. Contrast the non-centuriated areas, e.g. the Apennine foothills (bottom right). (A) Cesena, (B) Savio river, (C-D) Via Aemilia. See Fig. 13 and p. 156. Crown Copyright Reserved.





39. NORTH ITALY, between PADUA and TREVISO. This vertical photo covers an area of  $c. 3\frac{1}{4} \times 3\frac{1}{4}$  miles. It shows the use of a river (the F. Musone) as a boundary between the centuriated *territoria* of two Roman towns, with their road-grids differently orientated. South of the Musone are the modern roads preserving the  $20 \times 20$  *actus* squares of *Patavium*, and on the north side are those of 15 *actus* width which belong to *Altinum*. The small white arrows mark regular subdivisions. Note that almost all the fields are aligned north-south. See p. 166. Crown Copyright Reserved.





40. ISTRIA, near POLA. This vertical photo shows a part of the grid of Roman centuriation, based on squares of  $20 \times 20$  actus (776 yards square) preserved by minor roads and field-boundaries. There had been little progress in mapping this system since Kandler's work in 1858. Now, air photography has shown the details and total extent of the system. See p. 175. *Crown Copyright Reserved.*



41. ISTRIA, the western side of the ARSA CHANNEL. The straight white lines indicate existing field-walls on the lines of divisions in the system of Roman centuriation round Pola. Associated with them are the remains of large piles of stones cleared from the surface; they are arranged in straight regular rows, in areas long ago covered with dense scrub. See p. 177. Vertical photo. Arrows in the margins indicate the major *limites*. Crown Copyright Reserved.



view makes the topography clear. A branch<sup>1</sup> west of the R. Savio led straight to Ravenna. The eastern boundary of the system was evidently the river Rubicone (the historical *Rubico*); beyond this lay the territory of *Ariminum* (Rimini). North-eastward, the centurial grid extended up to the Roman road from Rimini towards Ravenna; and, on a different axis, beyond it.

A new addition to the system at Cesena is given by traces of regular *limitatio* along the east side of this Roman road and at right-angles to it,—being most prominent between Montaletto and Pisignano (a village with Roman origins). This belt of land up to 2 miles wide has many old boundaries and minor roads which lie exactly 10 *actus* apart. These traces are not shown on the *Carta Archeologica* (sheet 100/Forlì), nor by Mansuelli. Clearly this *limitatio* took the Rimini-Ravenna road as its base-line, making a tidy and thrifty use of the strip of ground overlooking the salt-pans.<sup>2</sup> It suggests a later addition, when fresh land was distributed; or alternatively an early *adsignatio viritim*.

A similar impression is given by an odd little patch<sup>3</sup> of centuriation that lies between the systems round Cesena and round Forlimpopoli; it is isolated and does not fit with the orientations of these big systems, suggesting that extra (probably heavier) land was taken under cultivation at a later stage.

We must now turn to a matter of wider significance:—the comprehensive information about the internal sub-divisions of the *centuriae* which the air photographs picture faithfully for the first time. No maps ordinarily record the enormous total of these small field boundaries with the same completeness or accuracy. A glance at the relevant 1 : 25,000 map-sheets will show how much is simplified or omitted.

I selected Plate 38 for illustration because it enables us to see the characteristics of a really large area, covering several square miles, on a single photograph. From this height the dominant characteristics emerge, with the field pattern resembling the warp and weft threads on a weaving loom. The fundamental feature is that the longer axis of the vast majority of modern fields follows a north-south orientation, as if magnetised like a compass-needle! The same is commonly seen in the systems in other parts of the North Italian plain, and is universal on the smaller centuriated plains adjoining Florence and Lucca in the peninsula. Obviously, this uniform preference is born of very ancient practice, maintained and exaggerated by the ploughman who has continuously tended to favour, and to produce, long thin strips which minimise the need for turning his ox-team.

<sup>1</sup> For its Roman origin, and the Medieval and later landscape, see Campana's article 'Decimo, Decimano, Dismano', in *Emilia Romana*, vol. i, 1-39.

<sup>2</sup> These *saline* were renowned for their salt-production in the Middle Ages, and probably were also important in Roman times. Nearby was *Ficulae*, a small Roman settlement and early Christian bishopric, replaced in the later Middle Ages by Cervia on the coast (Mansuelli, pp. 53, 56). The road from Cesena diagonally across the centuriation is aimed in this direction.

<sup>3</sup> Cp. Mansuelli, *op. cit.*, 68 and fig. 2. Similarly, in the area round Bologna there are several blocks of centuriation with different orientations. Some of those furthest from the town might represent additions that were made when the colony became better established. It is noteworthy that a town's *ager* could embody more than one gridded system.



When we come to inspect these systems on vertical air photographs of any scale up to 1 : 30,000, we are able to study, more clearly than ever before, the sub-units of regular size that can still be identified in the *centuriae*. I have mentioned that many of the squares still show traces of an ancient division into bands of equal width from west to east, between the *decumani*. But the chief problem concerns the smaller units of partition. These are the thin parallel field-strips which are aligned north-south, and which often number about 20 to 25 inside the west-east bands that cross the *centuriae*. How far are these plots the remains of Roman work? This is one of those difficult questions which does not admit of an immediate answer, but it does take us to the inner functioning of these landscapes.

While considering this particular problem we should note also the good examples of such fields to be seen on Plate 66 in Venetia south of Bassano. Can these be founded on a Roman origin? As regards the chief *limites* there is of course no doubt of this; they took their alignment from the Via Postumia itself,—a good instance of the use of a major road, instead of compass points, to supply the base line. The system was of 200 *jugera* units, differing in size from those at *Acelum* to the east and in orientation from the more famous zone to the south round Padua.

Reviewing the north-south field strips that fill the centuriated landscapes to be seen near Padua and Bassano, Prof. Fraccaro suggests that, *where most regularly preserved*, they may still substantially represent the outlines of a Roman field-pattern. This view might seem to posit a survival that is almost too good to be true, but in some specific groups of *centuriae* it seems highly probable. However, great care must be taken not to apply this judgment too loosely and comprehensively, or without regard to certain qualifying factors which I shall mention. To obtain fully representative data I made a comparative study of the characteristics of the north-south strip-pattern,—for which I examined photographs of thousands of square miles of centuriated and non-centuriated land in Italy.

Of course, even in those areas that were once centuriated we can see that the majority of these plots have visibly been shortened or lengthened, sliced or combined at various times; and even where they are regular and of uniform size we must be on the alert for the post-Roman regularisation of the fields. Particularly from the middle of the 18th century onwards, schemes of land improvement, for more intensive agriculture to feed the growing population, have encouraged the rectification of fields and hydraulic planning which even changed the course of some rivers. There is no doubt that the enclosure of fields with ditches, hedges or tree-lines, and methodical re-partitioning of property by 'improvers', made great and widespread progress in this period. The effects of this tidying and reconstruction of the field-pattern can be most completely seen and appreciated from vertical air photos. But the real difficulty, archaeological, is that the fresh strips laid by the 'improvers' kept to the same



north-south axis, and were of regular size,—thus producing pseudo '*limites intersivi*'. And as the centuriated areas have been continuously cultivated, the evolution of the field pattern has been continuing all the time. In most countries which can show ancient landscapes still in use, it is a false assumption to think of continuity as a static conservatism. Evolution in the fields proceeds even when the positions of the chief structural elements, e.g. roads and villages, are rigid. Further, the principle of laying the field-pattern in north-south strips has been applied also in adjacent zones of modern reclamation, outside the centuriation,—though these can easily be distinguished from the cultivated areas of ancient origin.

But the essential point is that this principle itself, as a method, must be rooted in ancient practice, and doubtless was fundamental to the structure of the Roman landscape in this region. When one studies the uniform polarity of the fields on the great land surfaces displayed on Plates 38 and 39, one must surely conclude: *Roma docebat*.

One feature which is noticeable on the North Italian plain is that the average width of the strips does not vary greatly, but that the length varies much more (cp. Plates 38 and 39). Here and there a modern farmer has put several strips together to make a wider plot. But generally there seems to be a preference for a certain average field-width. This usage is another contribution to the stability of the field-pattern. It does not represent the evolutionary stage reached in continual partitioning through changing ownership, but the explanation (like that underlying many ordinary things that we accept without question) is really quite complex. For guidance I presented the problem to practical farmers of wide experience. Much simplified, the reason seems to be that a preference for a field of particular average width is a normal development, from age-old experience that this is best for land-utilisation in the traditional manner of the region. This preference may seem indefinite to urban minds, accustomed to mechanical precision, but it has a sound basis in practice,—just as the 'chain' unit has in our own English field measurements. Ancient though the unit is, we normally plough in widths of 'chains' or multiples of them, even in fields of widely differing lengths. It has proved itself a rational unit of land-utilisation, both for convenience in ploughing and for effective surface-drainage. Ultimately, most investigations into customary field-units end by considering the fundamentals of ploughing. But alas, to argue back from the existing situation to the original rationale (which was self-evident to the ancient farmer) is notoriously difficult reasoning. A generation ago it was easier to generalise,—and to err. Closer study has brought greater caution, but we must not allow ourselves to be intimidated by what is, in the last resolve, a homely and practical matter. A recent critique by Mr. Nightingale has re-examined the question of 'Ploughing and Field Shape'.<sup>1</sup>

In North Italy the matter requires further careful research from the viewpoint

<sup>1</sup> *Antiquity*, 1953, 20-6.



of Rural Economy as much as from that of Archaeology. One most useful line of enquiry would be to examine estate-maps of a century or two ago which show the field strips in a centuriated area, and to compare the same strips as they appear today. Something of this kind was attempted by Rubbiani, using a local map dated 1742, when he was reconstructing the blocks of centuriation round Bologna years ago. Further work on the same principles is much needed.

There has been a natural tendency for such strips to become broader or narrower in the course of time by inheritance and consolidation. But we have some guidance as to the ancient methods of division, *ceteris paribus*, from the *limites intercisivi* preserved in Tunisia (p. 202), where we can study the small plots into which the squares were divided. In the best-preserved systems in North Italy some such traces are still discernible. The Roman grid of roads gave a secure framework for them. In detail, however, the reasons for the continued stability of the north-south field boundaries are embedded in agricultural practices, bound up with the crops grown and the continuity which they ensure. The methods traditional to this region have played their part; where local history allowed they have exerted their force.

Cereals were the chief crops of the Roman farmers on the North Italian plain. There were many big towns to be fed, and Dr. G. E. F. Chilver has reminded us<sup>1</sup> that the region was in fact organised on a city economy, with the city as the market for the grain grown in its *territorium*. Pliny (XVIII, 25) specially mentions the cultivation of panic wheat in Italy around the Po, of millet and of beans as a crop along the valley (XVIII, 30). *Rapum*, the turnip cabbage or rape colewort, was important also, and he adds: 'Next to those of the grape and corn this is the most profitable harvest of all for the land that lies across the Po' (XVIII, 34). The intermixture of grape and grain plays a vital part in most Mediterranean economies. Two crops are thus combined, in the *arbustum* described by Varro, Columella and others. The branches of the vine were trained in festoons between a line of supporting trees.<sup>2</sup> Pliny, when discussing the cultivation of the grape, specifically refers to the practice of training the vines between tall *rumpotinus* trees in the Po Valley; fig trees and poplars were similarly used. Today, young trees as replacements are naturally always added to fill and maintain the established lines.

Among other crops that were extensively cultivated by Roman farmers on the North Italian plain, we know of flax and lucerne (*medica*, mentioned by Vergil). The latter would be of major importance as feed<sup>3</sup> for the indispensable oxen.

<sup>1</sup> *Cisalpine Gaul*, 1941, 142 seq.

<sup>2</sup> Varro (I, viii) mentions that the people of *Mediolanum* (Milan) used lines of maple trees; cp. Columella V, 7.

<sup>3</sup> No doubt, rough grazing on the non-centuriated *loca inculta* along the rivers was important as an added resource, as today. The limits of the *territorium* of many of the towns purposely included valuable pasture on the hilly fringes, cp. Chilver, *Cisalpine Gaul*, 48, 144. Pelham has described the practice of transhumance in Roman Italy, the annual movement of flocks between hill and valley (*Essays*, ch. xiv, 'Pascua'). The principal grazing animals to be fed were sheep and goats (vastly outnumbering cattle), and these can be managed with odd scraps of pasture; see M. Cary, *Geographic Background of Greek and Roman History*, 18.



Columella was rightly enthusiastic about this valuable crop which returns nitrogen to the soil. Servius in his commentary on Vergil stated that Venetia was covered with it. Lucerne is a crop that lasts many years. Pliny, in his enthusiasm, claimed that a single sowing would last more than thirty years, but Columella gives the more practical figure of ten.

The extensive cultivation of such a long-lived crop as lucerne would also be a factor contributing to stabilise the Roman field-pattern, and the irrigation ditches that it requires in order to do well in North Italy add to this. Another factor which made for conservatism in the field pattern was, as we have noted, the need to protect the crops with tree lines. The Po Valley is too cold in winter for olives, but trees help to break the sharp winds, and in summer 'shade trees' are of great assistance, if judiciously sited. Pliny praises the plane, elm and alder as good shade-trees,—adding: 'This branch of knowledge is by no means to be despised, for in the case of every variety of plant, shade acts either as a kind nurse or as a harsh stepmother'. Of the plane tree he writes: 'Who would not be justifiably surprised to hear that a tree has been procured from another clime merely for the sake of shade?' (XII, 3). Pollarded trees supplied useful light timber when natural woodland was ousted by intensive cultivation,—they were a permanent support for the vines (XVII, 35), and the leaves of elm, poplar and oak were used as cattle feed (Cato, LIV).<sup>1</sup>

Irrigation, an important feature of summer tillage, exerted a strongly conservative influence from the time when its main lines were drawn; equally in winter a fixed system of well-maintained ditches was needed for drainage. Finally, the scope of the characteristic 'gardener-cultivator' in this region is defined within narrow limits, in relying on either the upper layers or the sub-soil at the right season for the right crop. All these factors contribute towards a relatively static landscape,—and there were others, both ecological and economic, which operated to produce the same results. On passing through this countryside Tenney Frank claimed a resemblance to Roman times in its 'orchard' cultivation.<sup>2</sup> 'Variegated' would be a more exact term both for the ancient and modern. There were not the same factors favouring the growth of *latifundia* as in other parts of Italy.<sup>3</sup> The soil was deep, black and rich; wine was money, small-holdings gave good returns, and as Dr. Chilver observes 'normally it must have been expensive to tempt the small man to leave his prosperous farm'.

In this chapter attention is naturally concentrated upon the use and cultivation of the lowlands, the milieu of centuriation. However we should always keep in mind the far greater areas of hills and mountains, which had natural resources that were reservoirs of great wealth,—and balance the economic picture. Analysis of the celebrated inscription from Veleia, south of Piacenza,

<sup>1</sup> Cato (c. 234-149 B.C.) had Central Italy in mind. Both he and Varro (c. 116-27 B.C., whose treatise has a wider geographical scope) came from the same district, Reate in Sabine country. Reate's land was divided *per strigas et per scamna in centuriis* (p. 213).

<sup>2</sup> *Economic History of Rome*, 2nd ed., 1927, 428-9.

<sup>3</sup> Chilver, *op. cit.*, 147-8.



has shown that *there* it was in the mountain valleys, devoted to pasturage and timbering, that the costlier estates grew up.<sup>1</sup> No doubt these same sources of wealth were profitably exploited on the margins of the centuriated systems in Istria and Dalmatia.

It is an accepted fact that the basic elements of things are the most difficult to analyse. One cannot kill the past, and the structure of the *centuria* had,—ingrained in its constitution,—archaic origins that never quite left it. Structurally it was, after all, no more than the sum of *jugera* or *heredia*. These may seem shadowy, for their origins in the agriculture of ancient Latium at the dawn of Rome or earlier cannot be produced for inspection. Before proceeding further with the examination of the large-scale systems that betoken a conquering State, we will try to get a little closer to the small domestic parcels of land from which this elaborate structure sprang. These units of rational size corresponded with ploughing technique, work done in a day, drainage, etc. The *heredium* and *jugerum* were essentially practical divisions to the very core of their being. They had their origin in domestic agriculture which, round the Mediterranean is preponderantly on a small-scale basis,—virtually an expansion of gardening. Small units like the *jugerum* and *heredium* fitted this kind of work. We meet them first as the ancestral farmer's portion: the first being the measure of his ploughing in one day, the latter enough for his needs as Varro tells. These are easily-worked units suited to the compact parochial landscapes of early city-states, but as they were based on practical units of work, the quasi-constants of ox and man in the field, they could be effectively transferred to the wide open spaces of North Italy and North Africa.

The ancient trinity of bread, wine and oil was the staple diet of the Mediterranean farmer, but bread is the chief of these. A unit of ploughing was the basis of the *centuria* and the oxen were fundamental to its being.

There was nothing theoretical or abstract about the *jugerum*. Long after the time of its ancient definition it was still the same essentially practical unit when Pliny wrote: 'It is a fair day's work to plough one *jugerum*, for the first time, 9 inches deep; and for the second time one *jugerum* and a half,—that is to say if it is easy soil. If this, however, is not the case it will take a day to plough half a *jugerum* the first time, or a whole *jugerum* the second time, for Nature has set limits to the powers of animals' (18, 49). Without hyperbole one may say that centuriation was founded on the abilities of the oxen. It is not surprising that Varro and others are explicit in their instruction for tending them well: 'See that the draft oxen are looked after with the greatest care, and be somewhat indulgent to the ploughmen to make them look after the oxen with more pleasure' (Cato, V, 6).

Notwithstanding the large estates which grew up, a dominant characteristic in Roman agriculture in Italy was its intensiveness. Attention to minute detail is urged by the contemporary writers, and is visible in the extant remains. This

<sup>1</sup> De Pachtere, *La Table Hypothécaire de Veleia*, 1920; Frank, *op. cit.*, 419.



certainly had its foundations in the humble beginnings of agriculture in the peninsula among villages of little account. We need not go back to prehistoric agriculture. For example, when we consider the allotment at Terracina (329 B.C.) we find that 300 settlers there were given only 2 *jugera* each.<sup>1</sup> There is no need to emphasise how the personal lot increased as conquered land grew and grew. Pliny (XVIII, 4) relates as well-known a saying of Manius Curius (early 3rd century B.C.) ‘“The man must be looked upon as a dangerous citizen, for whom seven *jugera* of land are not enough”—such being the amount of land that had been allotted to the people after the expulsion of the kings’. Again to quote Pliny, ‘Cincinnatus was ploughing his four *jugera* of land . . . when the messenger brought him the dictatorship,—finding him, the tradition says, stripped for the work [and probably begrimed with dust]. “Put on your clothes”, said he, “that I may deliver to you the mandates of the senate and people of Rome”’. Pliny had, of course, a didactic point to make:—that in *his* day the same lands were tilled by slaves whose legs were in chains and faces branded. Nevertheless, the facts were as he stated,—it was not simply a case of ‘A la recherche du temps perdu.’

The object of the farmer in the centuriated landscape was to extract the last particle from the soil. There is nothing new in this object of intensive farming. The *jugerum* had its equivalent in other indigenous measures in Mediterranean lands. Some of these are mentioned by Varro (I, x), the *iugum* in further Spain, the *versus* in Campania. Besides the small unit which formed the square *actus* (120 R. feet in each direction) called in Latin *acnua*, he also tells us of the tiny unit called a *scripulum*, in area 10 feet square. In dealing with agriculture of an intensive order, with so much manual work needed, it is not surprising that Pliny and other exponents of his day advise ‘It is the eye of the master which does more towards fertilising a field than anything else’. For master we may substitute bailiff on most estates. Cato’s advice in *De Agri Cultura* to a landowner was apt, no doubt,—but none I think can read with much admiration his parsimonious counsel in matters of detail. The whole tenor of his advice to the estate owner, in his treatment of men and beasts, can be summed up in one of his recommendations: ‘For the slaves, store all the fallen olives you can and the ripe olives which give a minimum of oil; issue them sparingly and make them last as long as possible’.<sup>2</sup> True, we find something of the same stinting economy in medieval agronomists or in the Paston Letters of the 15th century; but the cause is much the same,—exacting tillage by hand, technically primitive and therefore rigorous in application, with the majority of the field-labourers often verging on a minimum subsistence diet, whether in Roman *jugera* or medieval strips. We must return, however, to the archaeology of the remains in the field.

<sup>1</sup> It has been suggested that in Rome’s earliest colonies a great part of the *ager* was held collectively.

<sup>2</sup> For economic data, calculated from Cato’s figures, in terms of the *jugerum* and its yield, see Tenney Frank, *An Economic Survey of Ancient Rome*, vol. I, 160 seq.



## ALTINUM AND ITS NEIGHBOURS

This is not the occasion to debate the still uncertain origins of the method of centuriation. It does not, initially, require genius to think of a chess-board plan, as many periods and peoples can bear witness independently, but it does require special qualities of determination and organisation to apply it on a large scale. In most proto-historic communities mensuration began as a skill intimately associated with the priestly order, but by the time of the earliest known systems of true centuriation its practical execution was a matter for secular hands. As regards its immediate origins, these could have developed quite normally out of the gridded planning on the smaller stage provided by early colonial towns in Italy. We can rule out the fanciful 19th century reconstructions of the *terremare* from this evolution, but we might allow that Etruscan colonies with gridded streets (citing Marzabotto as the example) may have been one source of inspiration for regularised street planning in early Roman colonies (e.g. Cosa, p. 227), in conjunction with ideas which spread from the towns of Magna Graecia in the south. Methods proved in new towns and in military camps by the Republic would, with the gathering of experience and confidence, naturally be applied on a wider scale to the countryside in the 3rd century B.C. For the study of systems laid out in the early days of centuriation we can probably gain most from excavations in those that have been found by my air archaeology in Apulia, round *Luceria* (Lucera), *Herdonia* (Ortona) and *Aecae* (Troia). Traces of regular *limitatio* outside Cosa (founded 273 B.C.) have also been reported. When, by the conquest of the Po Valley, the Romans were presented with a fertile plain inherently amenable to this method, there was no experimental fumbling with centuriation but it was applied with a well-practised hand.

Much has already been written on systems in Italy, but the literature is widely scattered, chiefly in short articles,<sup>1</sup> and a comprehensive survey of the whole subject is badly needed. Viewed on the ground, as any train journey across the Po Valley will show, the remains of centuriation give one little conception of the great field-monument of the Roman world that they represent. A long straight centuriated road seen at eye-level, like those photographed on Plate 39, calls up no particular feeling unless perhaps a sense of great monotony, especially as intensive cultivation usually limits the view on either side to a few yards. Obviously enough, a vertical aerial view of the same road would be more expressive.

<sup>1</sup> To those already cited should be added several useful articles by F. Castagnoli, with their bibliographies: 'La centuriazione di Florentia' in *L'Universo* (Rivista dell'Istituto Geografico Militare), July-August, 1948; 'La centuriazione di Lucca', in *Studi Etruschi*, 1948, vol. XX, and 'Note al Liber Coloniarum', in *Bull. della Comm. Arch. Com. di Roma*, LXXII, 1946-8 (on the systems at *Luna*, *Alba Fucens*, *Capua*, etc.). Each of the two latter articles is illustrated by a war-time air photograph taken by the Allied Forces.

For all work on centuriation in Italy an indispensable aid is the group of maps by Prof. Fraccaro, *L'Italia Romana* (1 : 1½ million scale), in the *Grande Atlante Geografico*, 4th ed., 1938 (Istituto Geografico De Agostini, Novara). Cp. also the available sheets of the *Carta Archeologica d'Italia*.



We have mentioned that in the land-partition for new colonies some discretion was evidently allowed in practice, in the size of the units employed. This is well illustrated on Plate 39, which covers an area of 4 square miles on the fringes of two adjacent systems of centuriation which survive in the modern landscape inland from Venice. We shall first consider that which apparently belonged to *Altinum*, and about which very little has ever been written.

On the north side of the river (the Musone Vecchio) can be seen part of an extensive *ager centuriatus*, aligned north-south and east-west, which fills a big block of countryside between *Altinum*, whose site lies in a northern corner of the Lagoon of Venice, and Treviso (*Tarvisium*). This photograph reveals the interesting division of the system into units which average 1,740 feet across, or exactly 15 *actus*. Prof. Fraccaro proposes units of  $30 \times 40$  *actus* as the basis of centuriation. Many of the *limites* are preserved by field boundaries alone, and for this reason the system can be studied much more effectively from air photographs than from maps. For example, we can now see that its traces extend closer to *Altinum* than Schulten supposed. The *decumani*, as often in North Italy, are better preserved than the *cardines*, which tend to lose their identity through sharing the main axis of the field-pattern. Their remains are traceable across an area at least 15 miles long from east to west and 6 from north to south.

The ownership of this system is a question of great interest. To the north, it is clear that the marshy river Sile (the *Silis*) was its boundary. The present evidence supports the view that it in fact belonged to *Altinum*, which was once prominent as a residential town, a port, and the meeting place of major roads. Such a city ought to have had a big *ager centuriatus*. Its environs show little. However, it would be very natural if a large part of its original system had disappeared. In this region urban civilisation and its organised landscape were dealt a shattering blow by the destruction of *Altinum*, *Concordia* and *Aquileia*. In c. 635 *Altinum's* episcopal see was transferred to the less vulnerable island of Torcello (just as *Concordia's* was moved to Caorle). Today, *Altinum's* bare and wind-swept site beside the lagoon is one of the most forlorn places on this desolate coast at the head of the Adriatic. Prof. Fraccaro also feels certain that it belonged to *Altinum* (*Atti del Convegno per il Retroterra Veneziano*, 1956).

Another claimant for this zone of *actus* centuriation might be *Tarvisium*, the present Treviso which lies on the inland edge of the system. It was a town of lesser note than *Altinum*. But Treviso did not perish in the Dark Ages, and therefore its survival kept alive the portion of this centuriated landscape in its proximity. Schulten, who gave only a few lines to the system,<sup>1</sup> favoured *Tarvisium* as the owner. Against this, there is a point which he did not mention. Adjoining the opposite side of *Tarvisium* there is another block of centuriation on a different axis, and surely that is the grid which seems to have belonged to that town. Part of it can be seen on one of his maps (Taf. 5); the alignment is north-west to south-east, parallel and in sympathy with the Roman road to Monte Belluna.

<sup>1</sup> *Römische Flurteilung und ihre Reste*, p. 28 (in *Abhandlungen d. Ges. d. Wiss. zu Göttingen*, n.s. II, 1898).



*Cardines* and *decumani* are preserved by existing roads inside a rectangular area of  $8 \times 4\frac{1}{2}$  miles, with  $20 \times 20$  *actus* as the units of division.

We must return now to a study of Plate 39. Across the R. Musone, to the south, we enter the territorium of the city of *Patavium* (Padua) and here the centurial unit differs both in size and orientation with that found north of the river. This system of  $20 \times 20$  *actus* squares is known today as the 'graticolato Romano', famous for the preservation of its *cardines*, *decumani*, and regular divisions inside the *centuriae*. Plate 39 shows, in the clearest manner, the employment of a river as a boundary between two systems of centuriation, delimiting the *territoria*, and gives a comprehensive view of the essential characteristics of two distinct and differently orientated systems. But its value for analysis goes deeper; for one can easily trace the smallest topographical details that are linked and give the lines sub-dividing the area within a *centuria*. A comparison with most large-scale (e.g. 1 : 25,000) maps will show that an infinitely greater number of minor boundaries are visible on the air photographs of the same scale, and (to make this comparison closer) it so happens that the original print from which this Plate is taken had a scale of exactly 1 : 25,000. A complete picture of the minor roads, hedges and field-boundary ditches is clearly a considerable asset. Sometimes regular sub-divisions are clear on the maps, but often they only take shape when we make use of the full topographical data which the air photographs provide. The *centuriae* of standard 200 *jugera* size in the systems at Padova, at Cesena, and south of Bassano are divided internally into four equal bands,<sup>1</sup> which are always sited along the east-west axis. Air photographs show that N.E. of Padova, many were again split up into two, i.e. making eight narrow strips in a *centuria*. It is usually agreed that such transverse divisions of the *centuriae* into two, four or eight equal bands are (normally) derived from classical times, though probably they have later bred others like them. Sometimes they can be traced continuously through several successive *centuriae*.<sup>2</sup> The peasants today give the name of 'cavini' to these straight *limites intercisivi*.

An interesting fact which has emerged from the study of the details of the 'dead' Tunisian systems (p. 200), preserved by abandonment, is that we can often see very different units of subdivision in adjacent *centuriae*. In studying those systems which have remained in use (e.g. in North Italy) we must not look for too much uniformity in the traces of internal divisions.

On Plate 39 the black arrows indicate the direction of the *limites linearii*

<sup>1</sup> The Roman surveyors mention various specimen allotments. Blocks of 50 *jugera* were used as the *modus* or measure of property allotted in the colonies of the Triumvirs (Pauly-Wissowa, *Real-Encycl.*, 'Limitatio'). Thus a division into  $4 \times 50$  *jugera* was used at *Florentia*, and recorded in the *libri coloniarum* (Lachmann, p. 213, 6 = Pais, *Storia della colonizzazione di Roma Antica*, I, p. 16). This agrees with traces of a division of the *centuriae* into 4 equal units which is well shown by air photographs of the plain west of Florence to-day.

The system visible south of Asolo (*Acelum*) in N.E. Italy which is based on  $21 \times 21$  *actus* squares shows, as might be expected, traces of a division into three bands of 7-*actus* width.

<sup>2</sup> There are instances from Tunisia where such continuous subdivisions can be shown to be of Roman origin, pp. 198 and 202.



that enclosed the *centuriae*, with contrasted orientations. The small white arrows point to some of the regular west-east field-divisions which may be derived, in essence, from *limites intercisivi*, though probably renovated and tidied in later times. A continued preservation of *limites intercisivi* in the matrix of the modern field-system, embedded like a fly in amber, always excites a certain wonder. It would not be safe to say that every *centuria* there which is regularly divided today does, necessarily, perpetuate a Roman subdivision. Care has to be taken with individual cases, for it can be demonstrated that pseudo *limites intercisivi* can arise in modern times from regular property boundaries drawn parallel with the convenient base line supplied by the roads round the *centuria*. This is shown, for example, by a comparison between 19th and 20th century maps of the famous *limitatio* at Carthage.

An essential part of the problem lies in the way in which the longer axis of the fields is firmly 'polarised' from north to south, and part of the value of Plate 39 is the compelling way in which this is made clear. We can indeed believe that for 2,000 years cultivation has given a general obedience to this orientation, while trees were planted and irrigation streams fed and led on the traditional lines. But the survival of such boundaries depends on local circumstances. It can be seen that regular subdivisions inside the *centuriae* are much more rare in the system north of the F. Musone than in that to the south of it.

Further to the north-west, the marshes of the F. Musone also effectively separated the grid north of *Patavium* from another big grid that extends south from Bassano. This zone between the two systems was certainly never centuriated: but as rough grazing and woodland it would have been a useful 'waste'. To appreciate the impressive way in which the many great blocks of centuriation were dove-tailed together across the wide plains of North Italy the reader now requires a specially prepared map, overprinted in colour, on which the kaleidoscope of systems can be seen as a whole. I hope to produce a map of this kind, for with the aid of aerial mapping the picture is now growing so much more complete.

This system south of Bassano is especially well preserved round the town of Cittadella, and examples of its parallel *limites* on the decumanal axis are readily seen on Plate 66 (see also p. 267). They run from W.S.W. to E.N.E. as country roads and field-boundaries. Some of those illustrated are the remains of internal lines which subdivided these  $20 \times 20$  *actus* squares into four bands. Immediately to the east lay another extensive system of centuriation, south of Asolo (*Acelum*).<sup>1</sup> The units in this measured  $21 \times 21$  *actus*,—an unusual type of *centuria*. However, at Cremona blocks of  $20 \times 21$  *actus* are reported, and the Gromatici mention others of  $20 \times 24$  *actus*, etc. In short, the original term *centuria*, by an extension

<sup>1</sup> For the topography of these two systems and others adjacent, see the excellent analysis by Professor Fraccaro, 'Intorno ai confini e alla centuriazione degli agri di Patavium e di Acelum', in *Studi di Antichità Classica offerti a Emanuel Ciaceri*, 1940. This corrects details of *La Colonizzazione Romana dal Brenta al Piave*, by A. De Bon, 1933.



of the meaning, came to include units differing in area and form, but employed in the same manner.

### TRICESIMO AND AQUILEIA

Let us now consider some unusual variants of centuriation situated in north-east Italy, and not previously studied from the air. I propose to discuss the remains round Tricesimo (6 miles north of Udine), and north of Aquileia. Very little is yet known about these systems.<sup>1</sup> As the field-archaeology of centuriation expands, we naturally find more variants and unusual forms. They are welcome in themselves, but still more because the analysis of the whole subject becomes more realistic in consequence. Some good instances had been given in my interim reports on the systems found in Apulia. Such visible and tangible examples also help us to a more receptive approach to the entries in the descriptive lists called the *libri regionum* or *colontiarum*. In his critical edition of these sources Professor Pais took the view that some commentators had gone too far in distrusting their evidence. The apparent absence,—as it was formerly thought,—of surviving traces had thrown doubt on many of the systems mentioned in the lists. But one of the results of the aerial discoveries in Apulia has been to show that the relevant entries in the *libri colontiarum* can be confirmed accurate,—as I have briefly explained elsewhere (*Antiquity*, 1949, 69; and 1950, 89).

*Ad Tricesimum*, with its name signifying its position at the 30th milestone north of Aquileia, stood on the highway to *Glemona* (Gemona), a main route across the Alps and into Austria. Little is known of the place,<sup>2</sup> a small centre of communications near the entrance to the mountains. Today it is no more than a large village on the road, which bends to pass the hill still surmounted by the castle of the medieval fief; see Fig. 14.

West of Tricesimo the ground rises in low rolling hills, terrain unfavourable for centuriation (or, at least, for its survival); eastward the *Torrente Torre* (the Roman river *Turrus*) runs roughly north and south at this point, issuing from the mountains and making a natural boundary. The *limitatio* is preserved by existing country roads and by field-boundaries. In this level area nearly all the fields are thin rectangles with the longer axis from north to south, and because of this the *cardines* have not come through the centuries of use as clearly as the *decumani*,<sup>3</sup> for alternative north-south tracks can develop so easily. The Roman grid is best preserved near the river, away from the disruptive effects of the trackways which have radiated from Tricesimo; to north and south its remains fade away progressively, further from the community which was its main

<sup>1</sup> They have been noted by Prof. Fraccaro, and by Dr. Stucchi in his book on *Forum Iulii*, 1951, p. 91 (vol. XI in the series *Italia Romana: Municipi e Colonie*), and in his article 'La centuriazione romana del territorio tra il Tagliamento e l'Isonzo', *Studi Goriziani*, XII, 1950.

<sup>2</sup> An important inscription, found there, speaks of the construction of the walls and gates of *ad Tricesimum* (*C.I.L.*, I, pt. ii, No. 2648, and *Riv. di Filologia*, 1938, 134. Cp. *C.I.L.*, V, p. 167).

<sup>3</sup> We have already noted this tendency as typical of other systems in north Italy, p. 160 and p. 167.



protection and economic support in later times. It will be seen that the *limites* cross the Roman road from Aquileia to the Alps, and it is clear that we should be safe in restoring a gridded rectangle with Travagnacco in the south-west

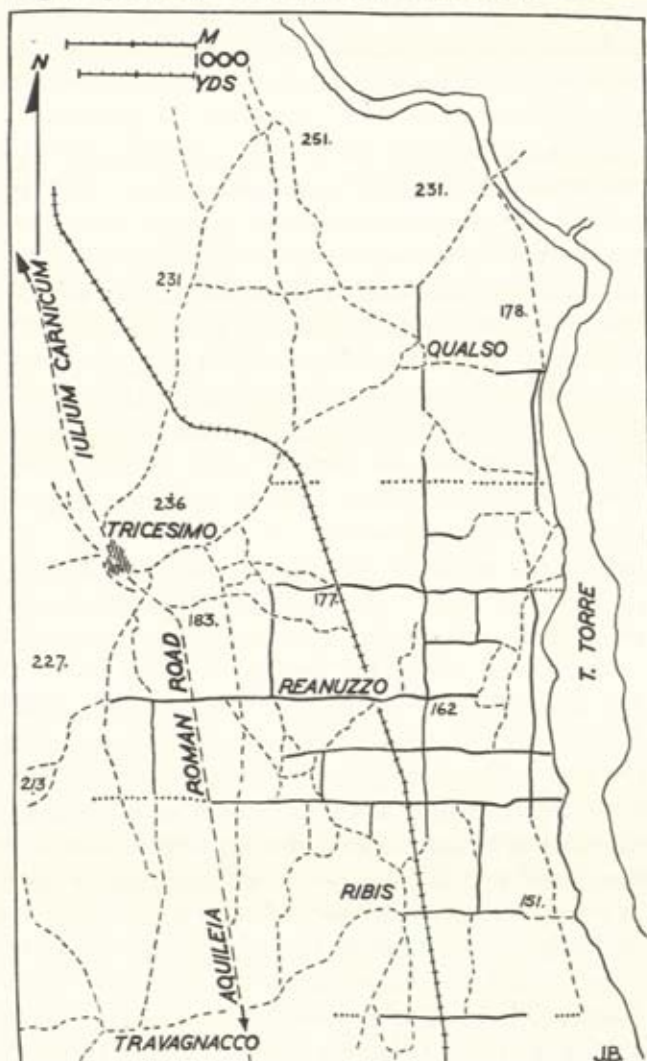


FIG. 14 Existing roads and field-boundaries preserving Roman centuriation near Tricesimo, 30 miles north of Aquileia, mapped from the air. The square units of division were of an unusual type, measuring  $12 \times 12$  *actus* (72 *jugera*). See p. 170.

corner and Qualso in the north-east corner, giving about 100 *centuriae* occupying this block of level ground. But, in this example, it is not so much the extent<sup>1</sup> of the system as its structure that concerns me.

<sup>1</sup> Dr. Stucchi would see a few more *limites* further north and further south. The course of the road leading west out of Reanuzzo is wrongly shown on the 1 : 25,000 maps. The air photographs show it to be straight, as on Fig. 14.

For this scheme of *limitatio*, a rare and interesting unit of subdivision was used. It averages c. 247 metres (1,390 feet) across, which is exactly 12 *actus*. The *centuriae* (although 'centuries' only in name) measured 12 × 12 *actus* each (area, 72 *jugera*). It is noteworthy that this unusual measurement was employed extensively as the basis of centuriation in this part of N.E. Italy, and, for the moment it will be enough to instance the adjacent system belonging to *Forum Iulii* (Cividale del Friuli) on the other side of the T. Torre.

To whom did the block of *centuriae* on Fig. 14 belong? It would seem that *ad Tricesimum* itself was not of sufficient importance. The orientation of the *limites* differs from those in the neighbouring system of *Forum Iulii* to the east, and also from those in Aquileia's system which lay immediately to the south and west. But, as we have already observed at Cesena and elsewhere (p. 159), a large gridded system could be later increased by smaller additions which had a different orientation while still within the same city's *territorium*. The centuriation round Tricesimo may have been an addition to Aquileia's; if not it should be associated with *Glemona* 8 miles to the north, a town of which little is known from Roman times,<sup>1</sup>—or alternatively it formed part of the *territorium* of *Iulium Carnicum* still farther north among the Alps, as Degrassi suggests. Further work is needed on this interesting problem.<sup>2</sup>

I should like to stress the specially interesting way in which traces of centuriation have survived in N.E. Italy. The roads and field boundaries which have preserved the Roman lines are much more wavering, intermittent and difficult to piece together than those in the Po Valley, or west of the Piave, or at Pola in Istria. The *limites* round *ad Tricesimum* are the best, but even these show how much feebler has been the hold of the Roman landscape on its successors, as we would expect when we remember the destruction of Aquileia and other cities of the region in the turmoil of the Dark Ages. Rural life returned to village parochialism. Centuriation as an organised road network evidently broke down, and even cultivation itself was abandoned over large parts of the area. In post-Roman times, if a village's lanes reached its own fields that was enough. There is often much to be said for not being too accessible, in a vulnerable frontier zone.<sup>3</sup>

But under the Empire this whole region would have appeared as completely systematised by its blocks of centuriation as those that still lie side by side along the Via Aemilia. On another occasion I hope to give a more detailed account of these systems in N.E. Italy which are far too little known. It has been a most interesting experience to survey this great area from the air, and to treat its problems and physiognomy as a whole, as is needful.

One of the chief tasks has been to reconstruct from slender traces the immense

<sup>1</sup> Attilio Degrassi, *Il Confine Nord-Orientale dell' Italia Romana (Dissertationes Bernenses)*, 1954, 44-5.

<sup>2</sup> Regrettably, the study by P. M. Moro, *Iulium Carnicum* (Bretschneider, Rome 1956) adds no useful discussion of this problem. See U. Ewins, *Papers of the Br. Sch. at Rome*, 1955, 88.

<sup>3</sup> Geography gave this region the permanent quality of a frontier March. For an illustration from its later history, cp. Palmanova, p. 271 and Pl. 68.



zone of regularly partitioned land that once must have belonged to Aquileia. Of this great city, founded in 181 B.C., there is no need to write in detail here. As the port at the head of the Adriatic it anticipated some of the commercial rôles later played by Venice and Trieste. After its annihilation by Attila, its population (or what was left of it) scattered. Some took refuge on the lagoon island of Grado, but Grado did not become another Venice. Obviously, the control of the inland *ager centuriatus* was gone for ever: it was abandoned to its own devices. Yet, naturally, a city of such magnitude would have possessed a very large *territorium*. The mapping of centuriation has helped us to see how large it was. But these traces are slight and have long been obscure; even Schulten gave only one line to note the existence of some 'vestiges'.

In the neighbourhood of the city's site the remains of *limites* are very few; and are virtually absent from the broad belt of very marshy land further inland. But from Palmanova northwards we reach the firm ground of the plain, and enter the great expanse of the *ager centuriatus* proper. To the north it extended to where Udine and Fagagna stand today, eastwards to the Isonzo, and west to the Tagliamento from Codroipo up to Dignano. The line of the Via Postumia between Codroipo and Palmanova approximately marks its southern limit. The geology of this part of the plain has a natural unity, too, and the limits of this very large system fit well with it. The orientation, N.N.W. to S.S.E. for the *cardines*, was apparently linked to that of the first part of the main road north out of Aquileia.

The peculiarly distorted and interrupted lines of the *cardines* and *decumani* make experience essential in deciding what topographical evidence to admit and what to reject. The need for discrimination gives particular interest to the search for the evidence here. After comparing a well-preserved system it is necessary to re-adjust one's standards on an entirely different basis,—to 'lower the bar' and to accept (after critical scrutiny) very fragmentary traces of centurial alignments, which at first glance might be dismissed as without any significance. Only a few small country roads, serpentine rather than straight, to-day bear witness to the orderly system that has perished. Naturally, it is helpful to see their precise course as it exists on the ground, rather than the more simplified course produced in map-making. Air photographs have, therefore, been able to give a more exact picture of the mutual relationship of the various fragments of the *limites*. Practice in examining such systems as this is a good preparation for the topographical study of still more disintegrated systems in Gaul (for example at Valence, p. 207).

Among the areas preserving traces, three are best:—north of Talmassons, the zone Gradisca—Codroipo—Beano, and that to the south and west of Fagagna. In all these it is notable, in view of the preference already observed to have existed in this region, that a division into units of  $12 \times 12$  *actus* fits best with the surviving *limites*.

No details, I believe, have so far been given in English of these interesting



remains of centuriation in north-east Italy; and although the aerial study of the region has helped (by supplementing the maps) to piece them together, we are still not yet in a position to place these systems in their historical niches with final security. For one thing, the historical record is itself obscure or insufficient on several points and periods in this area. It is worth, however, reviewing a few of the possibilities,—for the laying-out of centuriation is an important aspect of the effective Romanisation of the land.

One initial fact is that in 181 B.C.<sup>1</sup> Aquileia was established as a Latin colony in Gallic territory. Large allotments were used as an attraction. 3,000 *pedites* received 50 *jugera* (31 acres) each, the *centuriones* got 100 each, and the *equites* 140 each, according to Livy.<sup>2</sup> A calculation will show that an area of roughly 200 square miles (e.g. a zone of 10 × 20 miles) would be required to satisfy these allotments. The examination of air photographs of the marshy coastal land on either side of Aquileia confirms that this terrain (much of which has only comparatively recently been reclaimed and cultivated) could not have furnished the space.

But, on the other hand, the requisite area accords well with that of the large, level, quadrangular zone inland (and mainly to the N.W.) of Aquileia, which, as I have described, still preserves some traces of centuriation in the lay-out of the existing roads. There is little or no doubt that this was the scene of the centuriation which must have accompanied the foundation of 181, and these traces may therefore probably date from the original Latin colony. The centuriat square used was not the familiar 200 *jugera* unit, and the spacing of the *limites* seems to indicate that squares of 12 × 12 *actus* (72 *jugera*) were the basis of the grid. This does not appear particularly convenient for the allotments mentioned by Livy, but there is no record of Aquileia's centuriation being laid out a second time. In considering this unusual unit, there does not seem to be any cogent evidence that the Romans were respecting some pre-existing local custom or land-measure. I have already referred to variations in the size of the *centuriae* used elsewhere in Italy, and one may note also the strangely awkward units of allotment which, we are told, were sometimes awarded (e.g. 51½ *jugera* to each of the 2,000 Roman citizen colonists at Luna).

In the present state of knowledge it would be tempting to link the appearance of the adjacent systems of centuriation round Cividale (*Forum Iulii*), and round Tricesimo (i.e. south of *Glemona*) with the busy policy of town-formation in N.E. Italy, Istria and Dalmatia during the third quarter of the 1st century B.C. (which Augustus so particularly furthered). But this association is not proven

<sup>1</sup> For the date, see Pais, *Mem. Accad. dei Lincei*, vol. XVII, 1923, 'Serie chronologica delle colonie romane e latine', pt. i, 346.

<sup>2</sup> Livy also records, of 169 B.C., 'This year, when the ambassadors of the Aquileians asked that the number of the colonists should be increased, 1,500 families were enrolled by a decree of the Senate'.

Tenney Frank comments (*Ec. Survey of Anct. Rome*, i, 121) that the size of the allotments implies that the colonists of Aquileia were intended to have leisure for garrison duty and to draw their livelihood from land-rents, and that the same is true of the colony of Luna planted in 177.



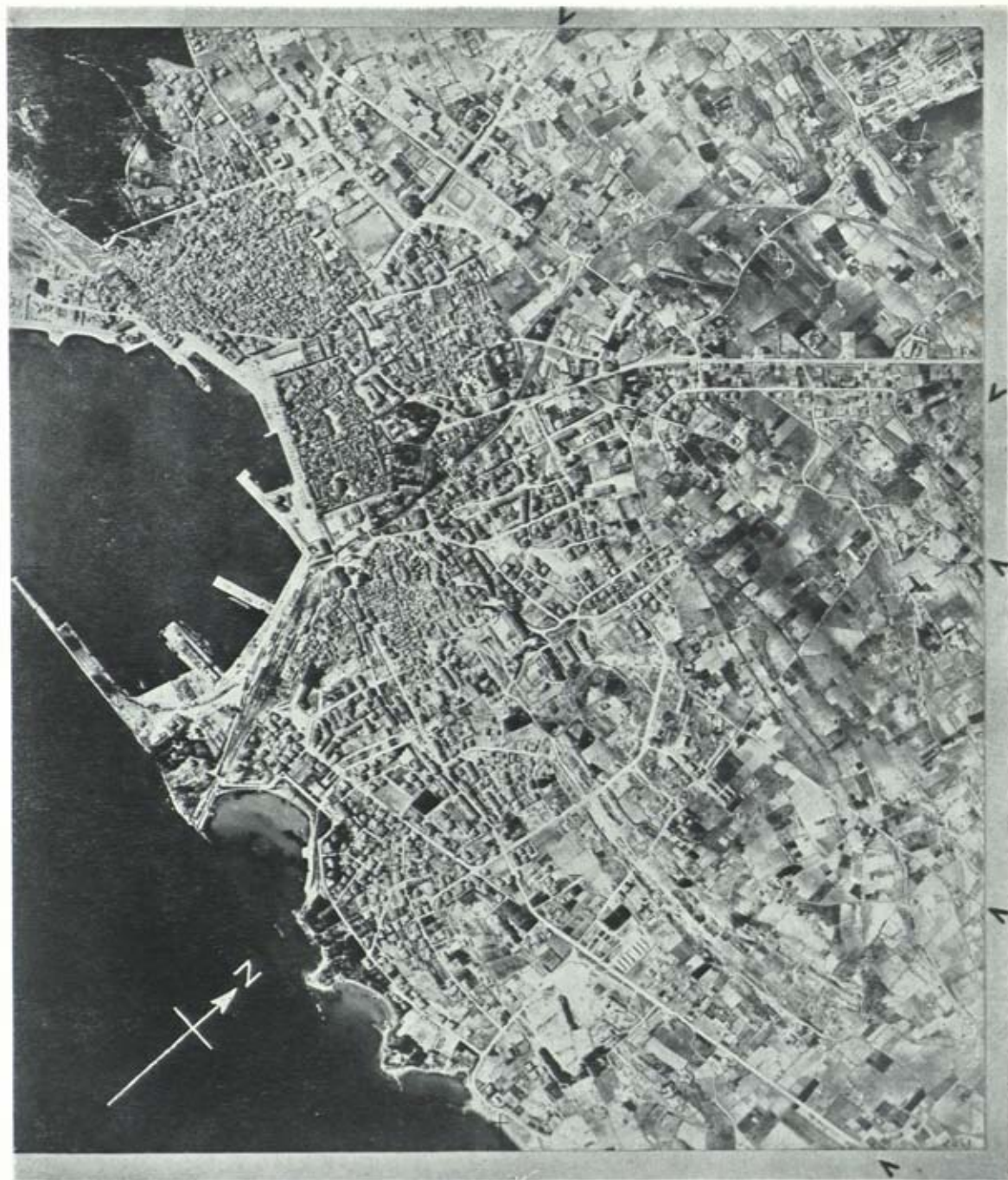


42. DALMATIA, ZARA. Roman centuriation squares of  $20 \times 20$  *actus* which were preserved by country roads and stone walls, and have been discovered from the air. This vertical view also shows the regular street-plan (of Roman origin) in the present town, a *colonia* of Augustan foundation. (G-H) main axial street. See p. 178. *Crown Copyright Reserved.*

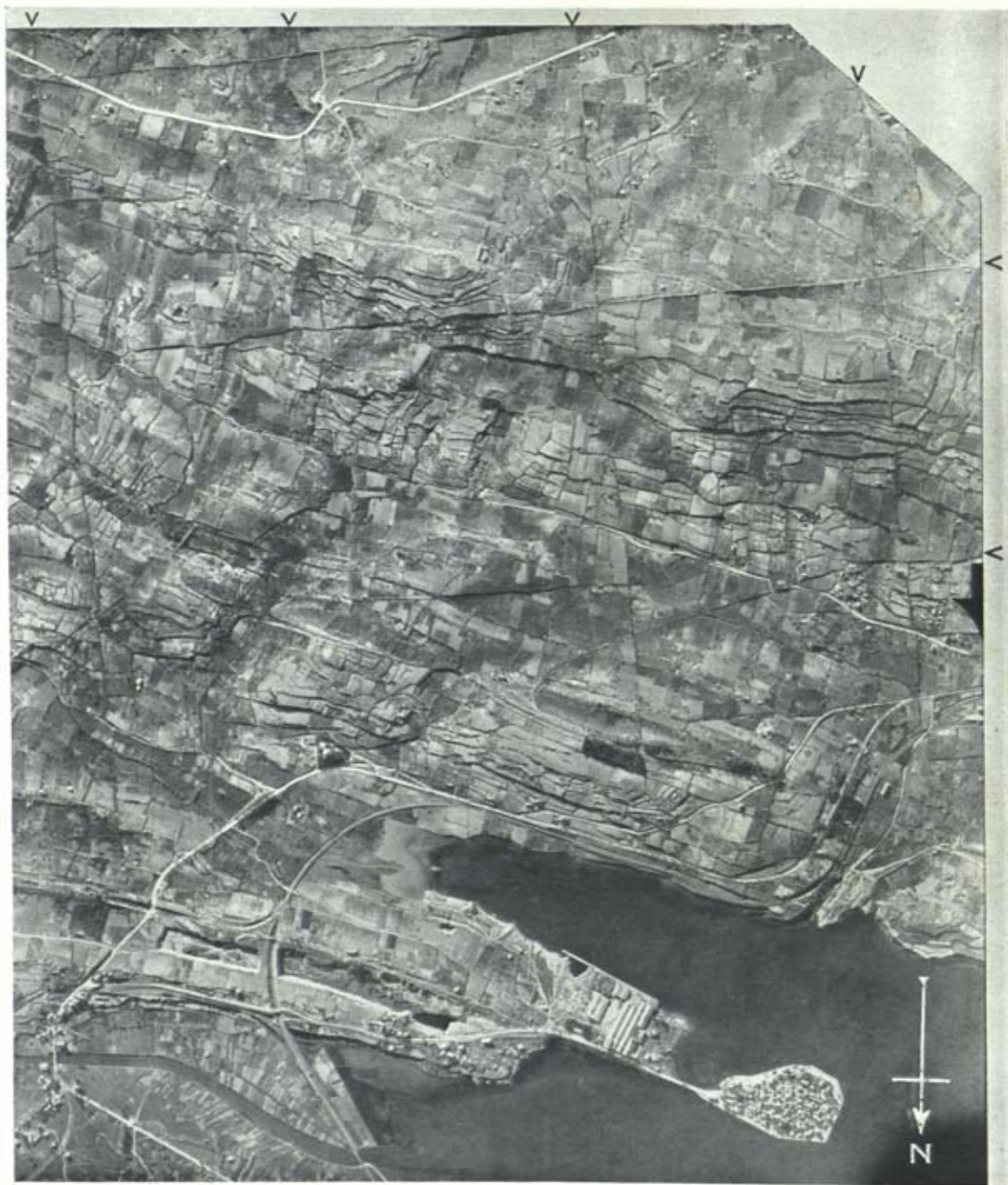


43. ZARA. A vertical view of one of the best preserved examples of Roman centuriation in the whole of Europe. It has been discovered from air photos and forms part of the system shown also on Plate 42. This illustration covers a coastal area just south of the town (see Fig. 16). Stone walls along the roads have 'fossilized' the *limites*, and also show an original division of one *centuria* into equal squares. *Crown Copyright Reserved.*





44. DALMATIA, SPLIT. Diocletian's Palace occupied the eastern half of the walled town beside the harbour (see Fig. 17). The centuriated grid, whose remains have been discovered from the air, shows that the northern gate of the Palace would have coincided exactly with the tangential line of a pre-existing centuriated road, which thus played a part in determining the precise siting of the gate and walls. Vertical view. See p. 186. *Crown Copyright Reserved.*



45. South of the site of SALONA. Traces of Roman centuriation, preserved by existing trackways. The squares equal  $20 \times 20$  actus (= 776 yards square). See p. 187 and Fig. 17. Vertical photo. *Crown Copyright Reserved.*



yet, and the 72-*jugera* squares used to construct these grids are] decidedly atypical of centuriation in this period, in which the 200-*jugera* square was characteristically the basis of division.

## POLA

On the Istrian peninsula at the head of the Adriatic, there is a comparatively neglected, but wonderfully preserved, Roman centuriated landscape which served the city-port of Pola. Indeed, with the exception of the systems revealed in unique detail in Apulia, it is in many ways the most interesting example of this kind of Roman landscape that is so far known from Europe.

This special position it holds for several reasons; the great size of the system, the excellent preservation of its lay-out, and, most important of all, the numerous details of property sub-divisions which are visible inside the Roman *centuriae*. These remains cover the well-defined zone of plateaux called 'Istria Rossa' in the south-west of the peninsula, where Roman farming could make most progress in familiar conditions. Further inland lie the hills of 'Istria Grigia', and, beyond, the mountains of 'Istria Bianca',—a practical classification. The limestone is almost universal, producing the special karst land-forms (poljes and dolines) and underground drainage for which the region is noted. Scarcity of water is a general problem. The 'terra rossa' is reddish sticky clay which retains valuable moisture and permits the cultivation of vines, olives and cereals; in Istria Rossa the climate and flora are roughly Mediterranean,—but northward, on the Carso, where the Bora blows savagely, the vegetation has a more Central European character.

The creation of this great system, planned and partitioned with a bold vigour (one could almost say violence) that far surpasses anything since attempted in the region, should be associated with the foundation of *Colonia Pietas Iulia* (between 42 and 27 B.C.), which Mommsen linked with Octavian's campaigns in Dalmatia in 35-33 B.C. But reasons in favour of 42-41 B.C. have been advanced by Deggrasi. The Roman buildings in the city are deservedly famous, but the remains of its Romanised countryside are really more impressive.

The best sketch-map of its centuriation has long been that first published a century ago by Kandler (1858). The system was mentioned by Legnazzi (*Del Catasto Romano*, 168-72, 1887) and briefly by Schulten (*Römische Flurteilung*, p. 29, 1898, without a plan).<sup>1</sup> No one, as far as I know, has dealt with it systematically

<sup>1</sup> The middle years of the 19th century were the first period of great activity in the discovery of centuriation,—primarily the result of the increased accuracy and spread of map-making. It was the Austrian Government's mapping of Istria which made it possible for Kandler to see that the centuriated landscape round Pola existed. This pioneer article (*Atti del conservatore*, 1, 1858) gave a schematic map of part of the system but did not describe its surviving traces.

Legnazzi and Schulten added little, but drew attention to certain place-names inside the system which



since. The study of war-time air photographs showed me that the system was more extensive than had been believed, covering an area of from 10 up to 15 miles round the city. In all this there was so much detail to be seen and mapped that I am reserving a full account for a future occasion, while commenting here on two illustrations only (Plates 40-41).

The *centuriae* are of the normal 200 *jugera* area, measuring 20 × 20 *actus*. The *Cardo Maximus* lies N.N.W.-S.S.E. It is said that severe plagues c. 1300, 1500 and 1630 depopulated the city to such a degree that its inhabitants were reduced to a few hundreds. That so much still remains of Roman Pola may be because it became partly an abandoned town; as it appeared when Napoleon I's engineers made their visit. Outside, in the country, the firm lines of many of the Roman field-boundary walls have been comparatively little changed by the more spasmodic efforts of later cultivators. The degree of preservation is therefore of an unusually high order. The *limites* come right up to the town, round which the ground is fairly level. But further inland the terrain soon becomes rolling and broken, a karst country pitted with the deep hollows of 'polje' formation. The *limites* continue up and down their slopes, unperturbed. Walled fields are necessary in Istria to prevent soil-erosion. Even so, winter winds carry away the loose top-soil, leaving a layer of stones,—and the farmer then frequently has to go several miles to obtain new earth from larger pockets of soil. The problems of farming on this limestone landscape have been much increased by excessive tree-felling, especially of the once extensive oak woods. As a result the soil from the plateaux has been washed down into the valleys, in one case to a depth of 25 feet since Roman times.

The sites of scattered 'villas' have given an indication of the manner in which the land was farmed during the Roman period. There are a few (very few) isolated farms today, and most of the land is tilled by peasants who live in the large villages and make long daily journeys in carts to their fields, starting at dawn and returning at dusk. The same thing happens throughout much of Southern Europe. But, as we were able to prove in Apulia, this was not always the chief basis of rural life, for there we excavated a series of small Roman farms, far from village or town, set at short intervals along the centuriated roads. In Apulia these daily long-distance journeys are common enough still, but small un-fortified<sup>1</sup> farms of single families are at last returning in numbers to this landscape which enjoys a newly-found security. The needs of defence and

---

suggest connections with agrimensorial origins, e.g. Limeto, Arcelle (*arcellae*, cp. *Feldmesser* I, 227, 5; 252, 15; 308, 25) and others. Near Parenzo, 20 miles N.W. up the coast from Pola, an interesting *cippus* was found, inscribed VIA. PUB. LAT. P. XX (C.I.L., V, 341); and a *Cardo Maximus* was nominally 20 feet wide. Parenzo (*Parentium*) had the status of a *colonia*, and I have found some divisions equal to 20 *actus*, 3 to 4 km. to the east. On the status of Parenzo and for the Romanisation of Istria, cp. the summary by Attilio Degraffi, *Il Confine Nord-Orientale dell'Italia Romana (Dissertationes Bernenses)*, 1954.

<sup>1</sup> One does find, however, a few large fortified farms in isolation, dating from the 17th to 19th centuries, walled and with towers pierced with musket-holes, like little castles.



protection in a compact village, and the very different structure of society in feudal nuclei from the Dark Ages onwards has, one may think, probably profoundly recast the peopling of the centuriated landscape behind Pola. From the far-reaching effects, this and other regions like it have not yet emancipated themselves. There is a strong case for systematic fieldwork on the ground in fresh search of the small and large Roman farms<sup>1</sup> which should be found along the roads. Patsch, many years ago, pointed to the finds indicating isolated Romanised farms between Salona and Naronna, further down the coast (p. 191, n. 3). It is certainly upon such problems,—to discover how the ancient landscape really ‘worked’,—that archaeology needs to concentrate as soon as the formal mapping of the traces is complete.

Helped by historical evidence, but still more by visible *limites* planned from air photographs, it will be possible now to establish the definite limits of Pola’s *ager centuriatus*; and very large it is, as extensive as Padua’s famous system. One very clear feature is the frequent subdivision of the *centuriae* into 4 equal squares containing 50 *jugera* each. Remains of this method of subdivision, undoubtedly Roman in origin (for it is quite foreign to later local practice), are found scattered throughout the system, and it may well be that this corresponded to the original lots in which the land was distributed to the ordinary colonists.

We can see what prodigiously hard work it must have required to divide and prepare such stony land for cultivation. Plate 41 shows the rocky coast on the western side of the mouth of the Arsa Channel (which seems to have formed the eastern boundary of the centuriation). Many coves, and narrow-cleft valleys, run inland like ‘coombes’ in Devon and Cornwall. It is a wild desolate shore, fringed with a jagged shelf. The rounded ridges along the coast have a thick covering of *maquis* scrub, mainly the uncultivated ‘waste’ of villages inland. Here and there patches of the darker-toned scrub have been cut, leaving irregular, lighter patches of moorland with a thinner covering of natural vegetation. The long straight white lines are the remains of big field-boundary walls, fallen and spread, of Roman origin. They are, in fact, *limites*, which can be traced continuously inland and are typical of Pola’s system. The walls were piled up from boulders collected from the surface of this singularly stony and unpromising soil, and even the hardiest vegetation has found it difficult to get root-hold or moisture enough to grow and cover them. Many rectangular Roman field-boundaries still emerge clearly, and very little ground was left un-enclosed by the thrifty cultivators (except a narrow strip of steep bare slopes above the sea which would be suitable for goats!) But the cultivation has since faded away.

Plate 41 shows another interesting feature. Inside these Roman boundaries

<sup>1</sup> Though not directly linked with our investigation we may note the wealthy ‘villa’ on Brioni Grande (an island off Pola) excavated by Gnirs (see Rostovtseff, *Social and Economic History of the Roman Empire*, plate 32). These islands, which can support a more luxurious vegetation than the mainland, have once again become a pleasure resort.



is a remarkable pattern formed by huge piles of stones (called *gromila* by Slavs, the word being also used for 'tumulus'). At their base, these stone-heaps which are roughly circular, are as wide as a house, up to 60 feet in diameter. They could have been formed during a long, or intensive, period of clearing the stony surface for cultivation. They differ from the stone huts called *trulli* still used in the fields of Apulia,—being much larger, more numerous and orderly in their distribution.<sup>1</sup> It will be seen that many of these *gromila* are arranged in rows parallel with the walls of Roman origin. Some heaps have been almost, or completely, swallowed up in dense scrub. They could have had a common origin in a programme of land-reclamation boldly conceived, perhaps when the better ground inland round the villages was being cleared. Did they begin to form in Roman times, with additions by later peasants? We can only note, at present, that these methodically arranged piles are exceptionally regular, localised to this part of the coast, and are not found separated from Roman *limites*. Dumps of stones are ordinarily scattered about, without the same signs of organisation. Traces of stone piles in association with the remains of *limites* continue for a mile or two further along the coast; many are now almost covered by trees and scrub, but it can be seen that they are set out in regular rows.

#### ZARA AND UGLJAN

Turning to the Dalmatian coast of Yugoslavia we encounter two well-preserved systems of centuriation which have lately been discovered by the study of war-time air photographs. That at Zara I described briefly in a preliminary article in *Antiquity* (December 1947), but I now have extensive discoveries to add; a full account of the other, at Salona, has not yet appeared in print.

The port of Zara (Plate 42) was a prospering entrepôt, thriving on coast-wise trade, for several centuries<sup>2</sup> before the creation of the Roman *colonia* of *Iader*. The position dictated that its fortune and energies should be directed seawards, then and since, rather than to the wild, hilly hinterland. The foundation of the *colonia* seems to date from the re-establishment of Roman authority in Dalmatia in and after Octavian's campaigns there in 35-33 B.C.<sup>3</sup> From this policy *Tergeste* (Trieste), *Emona* (Ljubljana), Pola and probably *Senia* (Senj) also benefited with special favours. An inscription<sup>4</sup> names Augustus as the '*parens coloniae*' of *Iader*, and there is evidence that it was properly equipped with the requisite officials. Roads radiated from it, north to *Aenona* (Nin), inland to *Nedinum* (Nadin) and *Burnum*, and south to the ports of *Scardona* (Skradin, nr. Sibenik) and *Salona*. In subsequent history, fate has on the whole treated Zara kindly. It got safely through the Dark Ages under the wing of the Byzantine

<sup>1</sup> Small stone huts (called *tregor*) similar to *trulli* are used in some Istrian vineyards.

<sup>2</sup> S. Casson, *Macedonia, Thrace and Illyria*, p. 317.

<sup>3</sup> M. P. Charlesworth, in *Camb. Anc. Hist.*, vol. X, 88; and *ibid.*, p. 903 and 939 (for bibliographies).

<sup>4</sup> *C.I.L.*, vol. III, pt. 1, p. 375, No. 2907.



Empire, only to succumb to the wanton sack of 1202 by the forces of the Fourth Crusade, side-tracked by the schemes of the Venetians and others.<sup>1</sup> The city was laid in ruins and many inhabitants fled into Hungary. From 1409, for nearly 400 years, it jogged along under Venetian rule. But even such disasters as that of 1202 were transient and there seems to have been no major break in cultivation for 2,000 years, although there has been a reduction in area.

This continuity explains the survival of extensive traces of Roman land-

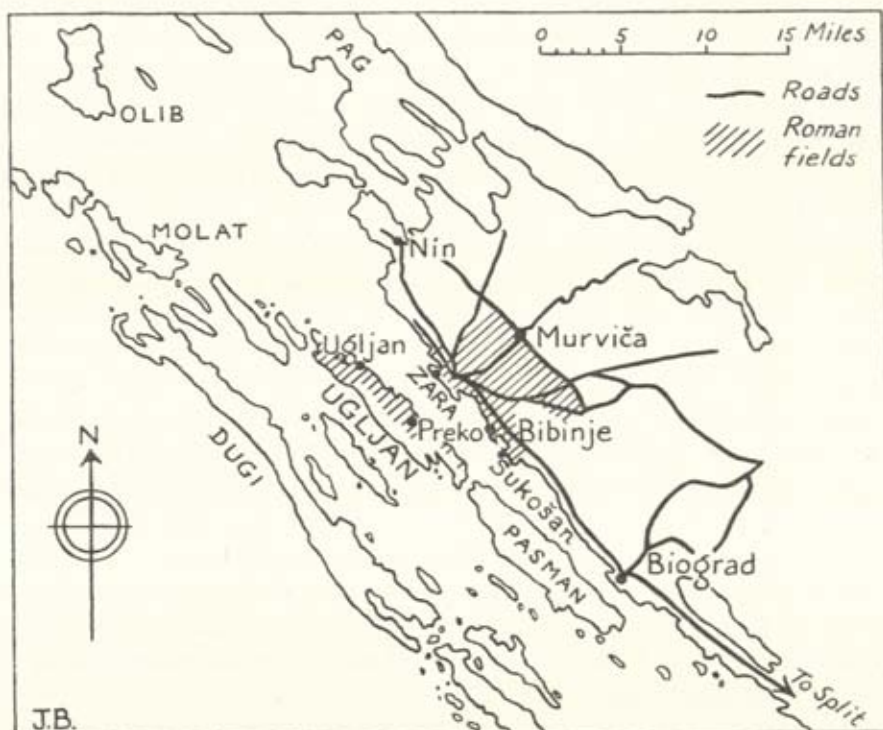


FIG. 15 Dalmatia. Map showing the extent of the traces of Roman centuriation found from air photos at Zara and on the neighbouring island of Ugljan. See Plates 42-3, and p. 178 seq.

division (see Fig. 16). Not even Kandler, who was so active in tracing centuriation in Istria, noticed it.<sup>2</sup> The units are of 200 *jugera*, as commonly found in Augustan *coloniae*, and are orientated to suit local convenience: i.e. the N.W.-S.E. axis of the coast and of the parallel, low limestone ridges behind. The zone

<sup>1</sup> Villehardouin gives an eye-witness description of the taking of the town. It was an important incident in the growth of Venice as a 'Great Power' in the Mediterranean, and a foretaste of the diversion of this Crusade to the capture of Constantinople.

<sup>2</sup> But, even near the town, at eye-level it is difficult to recognise the significance of the Roman *limites*, without the help of the air photographs, because of the maze of other boundary walls. On this coast such stone walls were the ordinary means of enclosing property, whether centuriated or not. Cp. the entry in the agrimensorial *libri coloniarum* (also called *libri regionum*) under *Provincia Dalmatiarum*: 'ubi saxa collecta ab utrisque partibus limites dederunt'; E. Pais, *Storia della Colonizzazione di Roma Antica*, 1923.

at the back of the town is called 'Ravni Kotari', or 'level corner'. The soil is often thin and very stony, and most *centuriae* are bounded by a high and broad bank or wall of stones, continually increased by others collected during cultivation. These have literally 'petrified' the Roman *limites*! But the soil is rich in patches, especially behind the first limestone ridge where there is a broad valley (the Cbobnica Dolnja) filled with fertile red earth (minus, alas, the archaeologically desirable stones), and split up into many tiny fields. Here the traces of the *limites*, as far as they can be recovered from field-boundaries, are naturally less complete. As far inland as this the land is fully cultivated, chiefly with grain (and olives and vines where sheltered). But beyond this point the terrain changes suddenly to a zone of level moorland. This belt, about 2 miles wide, runs parallel with the coast and then gives place to another long valley.

The war-time air photographs on which I first reported did not show any traces of Roman centuriated roads on this moorland, but I have since studied others which show conclusively that such remains are visible. This discovery is an important addition to my earlier account, and the plan which that contained is superseded by Fig. 16, which trebles the area of centuriation previously found. It is a good example of the value of examining 'comparative coverage'—photographs taken at other times of the year, with different conditions of vegetation and so forth. On the moorland, covered with rough grass, low-growing shrubs and bare rock, cultivation has altogether vanished but the straight lines of the Roman centuriated boundaries can just be distinguished under favourable conditions. All the other features of the landscape are without formal order, and thus these straight lines, though faint, are noticeable. On the ground they take the form of low banks (partly of stones) not more than a foot or two high, overgrown with grass, and likely to be missed by almost any field archaeologist on foot, unless purposely looking for them. And, of course, they would never be marked on any ordinary map.<sup>1</sup>

The discovery of these great agricultural systems holds moments of considerable excitement, as on this occasion when, studying the additional photographs, I saw faint indications of straight lines on the moor over two miles from the point to which centuriation had so far been traced. Their appearance had the 'feel' of antiquity;—their outlines though dim were unmistakable, like a picture by a master hand under layers of brown 'gallery varnish' or revealed by X-ray photography beneath a meretricious over-painting.

The outlines looked too weather-beaten for the recent past, much too regular for the unaided peasant. Then a square was identified and hasty calculations

<sup>1</sup> I wish to emphasise the strong contrast between the two very different forms in which this system of centuriation is preserved:—(a) by existing minor roads, field walls, etc., in the cultivated coastal zone, and partly to be distinguished on the latest maps, (b) by the slight earthworks on the moor which naturally are not recorded on these maps.

But both, though so different in their present form, refer to exactly the same system. It follows that the absence of regular boundaries on the maps is not necessarily a final verdict against the existence of centuriation.



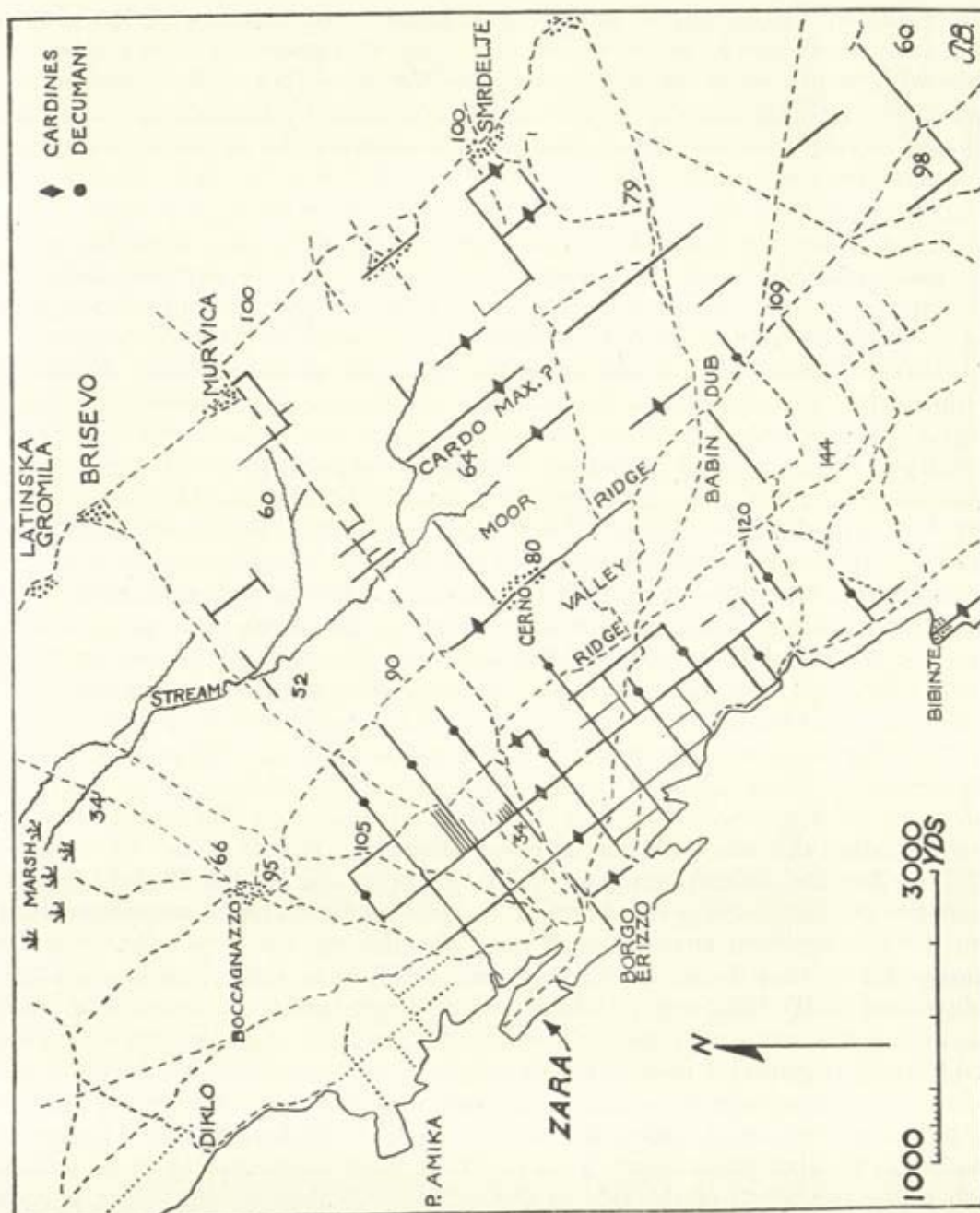


FIG. 16 Zara. A detailed map of the Roman centuriation discovered on the coast of the mainland. The units measure 20 *actus* square. Existing roads, field-walls, and minor earthworks preserving the lines of Roman *limites* ——— Straight roads on a different axis ..... Other existing roads - - - - - Villages ..... Spot-heights in metres. See Plates 42-3.

were made to see if it agreed with Roman measurements and with the  $20 \times 20$  *actus* units found on the coast. It did so. Beyond its *limites* there was a gap, but soon other *limites* were distinguished (some barely visible in their heath-land covering) continuing the same alignment, and little by little the *cardines* and *decumani* were pieced together across about 8 square miles of moor, linking-up with those on the coast.

But it usually requires many hours, spread over a long period of close study, before one finds such new evidence of an ancient landscape to reward the work, and then, after the brief first phase of discovery, a lengthy sequel of research and interpretation is inevitably required to make it ready for publication, and to fit it into the framework of local history which may be a shaky structure.

To north<sup>1</sup> and south, up and down the coast, the cultivated zone shrinks to a thin strip. Traces of centuriation are continuous as far south as Sukošan (Fig. 15).<sup>2</sup> For some distance beyond this point the mountains come down actually to the shore, and centuriation would be impossible.

We now have evidence of 12 parallel *cardines*, from north-west to south-east. Did they extend farther inland? There is no major natural boundary, and the ground continues to be fairly level. I have no evidence that the system stretched farther in this direction, but it is proper to draw attention to the problem. It is perhaps surprising that no traces have been visible northwards towards Nin. However, the total known area of the system, including Ugljan's centuriation, is quite large,—for example as big as the system reconstructed round Pisa by Prof. Fraccaro. One of the *cardines* on the moor behind Zara is of special interest, for its remains are strongly marked and it seems to be the longest. It is distinguished by unusually prominent remains of a boundary bank or ditch on both sides, leaving a wide grassy space about 20 feet across (or more) between them. Possibly this was the *Cardo Maximus* of the system.

Of the *decumani* we can identify at least 13, and at the south end of the system there are indications of 4 more which are still being studied. It is noteworthy that the long straight road from Zara to Murvica is exactly parallel with the *decumani* for most of the way, and is doubtless of Roman origin (though it is not a *decumanus* itself). The way in which various fragments of these centurial lines can be located on exactly the right alignment, in spite of large gaps where no visible trace survives, is unfailingly impressive.

Inside the best-preserved centurial squares, near the town, most of the surviving field-walls twist and turn to follow the terrain. Several *centuriae* are, however, divided in regular proportions. Two contain consecutive strips of equal width, each being one-tenth of the side of the square. Another, on the coast, is split into two halves, one of which is bisected equally. This certainly should be

<sup>1</sup> Near Amika Point (Fig. 16) are a few noticeably straight roads and field-boundaries, but they do not form part of the original 200-*jugera* units of centuriation.

<sup>2</sup> Further attention is being given to the southern end of the system, where the remains are fragmentary and require very careful interpretation, and also to possibilities along the fertile eastern coast of Pasman island.



allowed a claim to Roman origin, as a normal method of subdivision into 50-jugera lots, found at Pola (p. 177) and elsewhere. Close to the town, suburbs have interfered with the *limites*, and also around Borgo Erizzo where Catholic refugees from Moslem Albania settled in 1823. It has, of course, long been known that the town of Zara preserved evidence of a Roman street-plan,<sup>1</sup> and that its chief street followed the line of the present main thoroughfare, the 'Calle Large' down the centre of the long axis of the peninsula site. But it can be seen, in the vertical air view, that this axis of the town-plan and the corresponding axis of the centuriation are not exactly parallel. This point requires investigation.

The use of *limitatio* on islands off the Dalmatian coast was unknown hitherto. Its discovery illustrates a further facet of this Roman method in action. My study of war-time air photographs revealed definite remains on the island of Ugljan or Uljan which faces Zara, and also on Hvar which lies south of Salona.<sup>2</sup> Ugljan (Fig. 15) measures 14 miles long but not more than 2½ miles wide; at one point it is little more than 2 miles from the mainland. At the north end the relief is low from coast to coast but the south end is mountainous, and the south-west coast is very steep, without good anchorages and almost uninhabited. It is the east coast which is most favourable to settlement, with a string of villages today. Wine and oil are its chief products, fishing the chief occupation. It was naturally this coast which was divided-up by centuriation for Roman cultivation. The *limites* are preserved by stone field-walls, and by minor roads and cart tracks. The remains of the original grid are fragmentary and their significance was not immediately obvious even on good vertical air photos. There are many gaps in the boundaries that survive, but careful measurements showed that 20 *actus* units had been used as on the mainland system, and many subdivisions can be seen. In passing, we should note that only some of them are indicated on the latest 1 : 50,000 post-war maps (revised from air photos). This again emphasises the importance of working directly from the photographs whenever possible. The orientation of the Roman boundaries was taken from that of the island's axis, from north-west to south-east. Remains are continuous for at least 8 miles (13 km.) along the eastern side, but much of the remainder was never centuriated. The system on Ugljan must have belonged to *Iader*,—and island and mainland were combined in a very well-ordered and effective piece of planning inside the *territorium*.

### SALONA AND HVAR

The most important Roman *colonia* and port in all Dalmatia was *Salona(e)*,<sup>3</sup>

<sup>1</sup> See Dyggve, *Récherches à Salone*, 1928, vol. i, 16, with suggested reconstruction of gridded street-plan.

<sup>2</sup> A more detailed account of the systems on Ugljan and Hvar, and of the results of my study of other islands and of the lands of other Roman *coloniae* along this coast, will be published later.

<sup>3</sup> Salona is c. 100 miles north-west up the coast from Ragusa (Dubrovnik), and about midway between that place and Zara.



near Split (see Fig. 17). The ruins of the large walled city lie at the head of Kastelan Bay, the 'Sea of Salona', almost closed by the island of Čiovo. It is an ideal site, facing south with a sheltered anchorage, a fertile coastal belt (of unusual extent for Dalmatia) outside the gates, and protective mountains rising abruptly north and east. Geographically and historically Salona lay on the threshold between the Mediterranean and the Balkans. Again and again there has been a fundamental dichotomy, usually hostile, between this coast and its continental hinterland.

To the south and west of the ruined city, and occupying the only easily cultivable ground, I have been able to trace the outlines of a complete centuriated landscape,<sup>1</sup> discovered from air photographs taken during the War. This is not the flat 'billiard-table' terrain that we often associate with centuriated systems. The peninsula between Salona and Split, although level in patches, is mainly 'broken' undulating ground, with 'tors' as in Devonshire. Mr. W. L. Brown, who kindly examined a few of the *limites* on the ground on my behalf, reports that the full significance of the centurial straight lines would not be immediately obvious at eye-level. None the less, it is strange that their significance has not been recognised from maps (but see p. 180, note 1), especially in view of the long-standing archaeological interest in the ancient cities at either end of the system. One notable feature is that the *cardines* were aligned *across* Kastelan Bay. To this new information, careful fieldwork on the ground will be able to add valuable detail.

The centuriation, of course, belongs to Salona and not to Diocletian's palace at *Spalatum*. It is as a Greek settlement<sup>2</sup> that Salona first appears, becoming a place of some importance in the last two centuries B.C. It lay astride two very ancient land-routes, one being the coastal route down the east side of the Adriatic, the other inland through the important pass of Klis. During successive Roman campaigns to conquer and hold down the independent-spirited people of this coast, Salona was several times besieged. Roman traders were well established by the beginning of the 1st century B.C.,<sup>3</sup> and thereafter it became an important strategic 'jumping-off point' into the Balkans. The exact year in

The site of the city lies 3 miles N.E. of Split, at the mouth of a river (the modern Jader) whose delta has been much built-up by mud since Classical times,—silting the ancient harbour. On Vranjica there are Roman sarcophagi 3 feet under water. Dyggve places the original road-crossing of the Jader at the point occupied by the present village of Solin. The river, only 4 miles long, issues fully formed from a mountain, like other underground rivers in this karst landscape.

For its history, buildings and the excavations, cp. Bulić, *Salona: Studio storico-epigrafico*, Spalato 1885; Dyggve, Brøndsted, Weillbach, *Recherches à Salone*, 2 vols., Copenhagen, 1928, 1933; *Forschungen in Salona*, 3 vols., 1917, 1925 and 1939, by Gerber and others; Dyggve, *History of Salonitan Christianity*, 1951.

<sup>1</sup> See Plates 44-46.

<sup>2</sup> *Issa*, a Syracusan colony, was founded on the neighbouring island of Vis in the 4th century B.C., and from *Issa* settlements were set up at *Tragurion* (the modern Trogir) and *Epetion*; another sprang up at Salona probably a little later.

<sup>3</sup> In the first half of the 1st century B.C. we meet it as a walled *oppidum civium Romanorum* and *conventus*; in 59 B.C. Julius Caesar set up his H.Q. for the province here. Bulić (*op. cit.*, p. 12) discusses Caesar's connection with the foundation of a colony. Cp. A. Degraffi, *op. cit.*, 1954, 99.



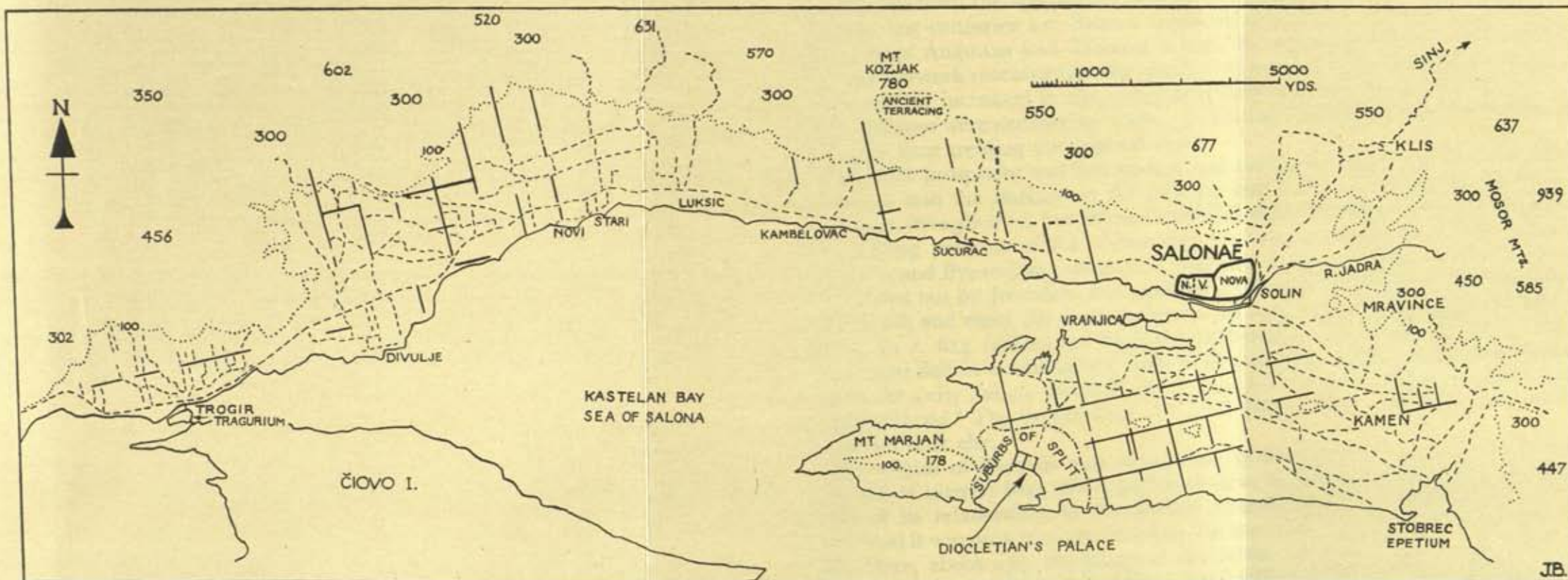


FIG. 17 Salona, on the coast of Dalmatia. Remains of the centuriated system of Roman roads round the site of the *colonia*, which were discovered from air photos. The units were 20 *actus* square. Existing roads and field-walls preserving the lines of Roman *limites*: ——— Other existing roads: - - - - Spot-heights in metres. See Plates 44-6, and p. 183 seq.





which it was raised to the status of a *colonia* is not certain, but the approximate period is not in doubt. Frothingham would put this between 39-33 B.C., a reward for loyalty in the Civil War. Its title *Colonia Martia Iulia Salonae* was, Mommsen urged, an indication of its foundation before the Augustan period beginning in 27 B.C. At present we have to be content with balancing alternative possible occasions during these years. The most general view is that the foundation was in accordance with Caesar's ideas which Augustus put into practice, and that it therefore received the appellation *Iulia* in his memory.

In the last centuries B.C. Salona consisted of a small walled town, the *urbs vetus*. Under Augustus and Tiberius it grew in importance as the basal point of a road-network reaching into the interior. As a centre of trade and administration it quickly increased in size, expanding eastward and also westward. These large additions were enclosed by walls,—producing an impressively long frontage and more than trebling the original area.<sup>1</sup>

The city's prosperity was first shaken and eventually shattered by barbarian incursions into the Balkans in the late 4th and early 5th centuries. The city walls were strengthened, but the surroundings were devastated and presumably the outlying portions of the centuriated road-system began to wither. After, the Goths and Byzantium contested it, the latter being successful. Some building was carried out by Justinian, but repeated onslaughts of Avars<sup>2</sup> on Dalmatia in the late 6th and early 7th centuries broke the resistance of this ancient civilised centre. In c. 614 (others say 639) the barbarians took it and burnt it. The inhabitants fled in all directions, some to Ragusa (see p. 273), some to *Spalatum* (Split). As a city Salona was finished: its tumbled ruins became a quarry for the neighbourhood.<sup>3</sup> The insignificant village of Solin, nearby, preserves the name today but little else.

The origins of *Spalatum* and its survival as Salona's successor, have always been full of interest from many points of view, to which we must now add the study of its relationship to the Roman centuriated landscape. Strangely, it seems that it was only at a late date that this bay of *Aspalathon* acquired particular note. Here, about 293, the Emperor Diocletian (born, it is said, in Salona or the vicinity) began the building of a great fortified residence, luxurious and yet semi-military; built after the semblance of a Roman camp but also akin to the

<sup>1</sup> I am grateful to Professor Dyggve for advice on the town plan. For the sequence of developments and the dating of the extensions to the walls, see his conclusions in *Récherches à Salone*, II, 138-40 (which revise the plan printed in Vol. I, p. 14).

<sup>2</sup> Again bringing Asia to the Adriatic as before and since; originally they were from the Steppes, moving into S. Russia and S.E. Europe in the 6th century; a semi-nomadic riding-people of Turkic-Mongol mixture embodying subject groups, which attacked Constantinople in 626. See Grousset, *L'Empire des Steppes*, 1948 ed., 226.

<sup>3</sup> In the early Middle Ages and in the 17th century, great damage was done by the destruction, removal and re-use of building materials. Desultory digging began c. 1821, and continued throughout the 19th century. The Austrian and Danish excavations have since cleared a number of major buildings systematically, notably the early Christian churches. Intensive peasant cultivation inside the city area has so far prevented the aerial view from locating traces of buried streets or buildings.



despots' palaces which we find up and down the Orient before and since. Hither he retired for peace of mind<sup>1</sup> after his solemn abdication on 1 May 305, at Nicomedia, having reigned for twenty-one years. The magnificent setting of *Spalatum* was in keeping with the dramatic nature of the event,—the immense bulk of the palace on the water's edge inside a towering rectangle of walls, with the Kozjak mountain mass in the background.

It appears (Pl. 44) that the layout of the centuriation may have had some influence on this famous palace's plan: namely, on the spot chosen for the 'Porta Aurea'. This principal gate was placed at the middle of the northern side of the square walled enceinte. We can now see that it stood exactly where it would straddle the line of an important Roman road in the system on the peninsula, i.e. on a *decumanus* leading towards Salona. Although the last part of this *decumanus* has been obscured by modern houses in the environs of Split, its alignment can be precisely calculated by means of the vertical air view. The co-incidence of the position of the Porta Aurea with the tangential line of this road is too precise to be accidental. What could be more natural than that the Palace's siting should be arranged with some relation to the existing road-system? Of course this *decumanus* was not the main route from the Palace to Salona, for a more direct road<sup>2</sup> which issued straight from the Porta Aurea was built as the chief link between the two places.

After the death of its owner the palace was turned into an imperial weaving factory, and eventually lapsed into decay. Still, early in the 600's its fortress-like walls could yet make an effective refuge for many fugitives from Salona. 'But how desolate was the land, a shadow of the sleek and confident past'. The centuriated roads in the immediate vicinity doubtless remained in use, as they still do, but very few regular boundaries survive inside the *centuriae*. It was, in fact, Spalato which henceforth took charge<sup>3</sup> of the living landscape, and which promoted the local survival of these, as of other, traces of an ordered Classical world.<sup>4</sup> Certainly the centuriation is best preserved close to Spalato, instead of round Salona. As a picture of life in the Dark Ages, the contrasted fates of these two communities mirror the times.

To return to the Roman countryside. It was divided in a typical manner,

<sup>1</sup> Gibbon's majestic account should not be neglected. It quotes the famous reply attributed to Diocletian, when Maximian asked him to resume Imperial rule, that if he showed his visitor the cabbages which he had planted with his own hands he should no longer be urged to relinquish the enjoyment of happiness for the pursuit of power. While Diocletian was in residence and attending to this microcosm we can be certain that the centuriated system outside the palace was kept in good trim.

<sup>2</sup> Shown on the Peutinger Map, a 13th century copy of a map which dates from the time of the Empire (2nd to 4th century); cp. Dyggve, *Récherches à Salone*, Vol. I, p. 21.

<sup>3</sup> For its medieval history, see Voinovitch, *Histoire de Dalmatie*, 2 vols., Paris, 1934. The walled city was doubled in size.

<sup>4</sup> One legacy from this ancient landscape even reached our own. The first to make a detailed reconstruction on paper of Diocletian's palace was Robert Adam, in 1757. His tour of Italy and Dalmatia was made deliberately to qualify himself for the leadership of English architecture, and Spalato provided one of the sources for the Adam style. Summerson, *Architecture in Britain, 1530-1830*, pp. 252-4.



using  $20 \times 20$  *actus* squares of 200 *jugera*. A feature that deserves notice is that the axis of the grid of Roman roads on the Split peninsula ran 'against the grain' of the lie of the land, and over-rode obliquely the geological formation of parallel limestone ridges that travel its whole length from east-south-east to west-north-west. Though the soil itself is fertile, its conservation and management need considerable attention, and the Roman settlers, while terracing the rocky slopes, would have had a hard time of it initially in the Romanisation of this Balkan countryside,—though it is no more intractable than the Apennines.

The Roman roads which enclosed the *centuriae* survive chiefly in the form of country trackways and lanes, with occasional gaps, and short détours where man and beast later ambled off the straight course. The existing main road eastward from Split today follows one of the *decumani* for about a mile outside the town. Some of the Roman roads must necessarily have been rock-cut at points where they cut across the axis of the ridges that run down the length of the peninsula's spine. Boundary walls of piled-up stones have effectively preserved other *limites*, as at Zara.

Immediately north of Salona, between the city and the upper mountain sides, the first slopes rise naturally in a series of 4 or 5 broad, parallel terraces. But these, although parallel with each other and very probably utilised and improved by ancient cultivators, are not parallel with the west-east centurial axis and do not influence that system's alignment. There are no definite traces of centuriation in this area, which was doubtless already well cultivated with vines, orchards and gardens by the pre-Roman town. Ancient and modern stone quarries are sited on the terraces along this 'stepped' hillside.

Inside the *centuriae* there are very few traces of straight property divisions and field boundaries, *limites intercisivi*. On level ground near Spalato, however, there are one or two long straight field boundaries parallel with the *cardines*. It is very possible that other such subdivisions existed but have been abandoned, for there are gaps in the centuriated roads which we can be sure were complete in the original layout.

But it would not be surprising if the internal boundaries had lapsed hereabouts, for, as I have said, this system was arbitrary and ill-conceived in as much as it ran counter to the prominent geological structure of the surface of the Split peninsula. As a piece of practical planning and agricultural land-utilisation this portion of the system seems clumsy in its topographical setting, particularly if the *centuriae* were ever partitioned into small regular plots. A doctrinaire division into thin strips would, at many points, have been almost unworkable by the man on the spot. If elaborate rectilinear *limites* did exist inside the squares, later peasants have sensibly abandoned them for terracing that follows the lie of the land, natural drainage, etc. I think it possible, however, that straight *limites intercisivi* were only used to break down these *centuriae* into a few big property-blocks and that the general structure of the field-pattern inside these



individual holdings may have mainly followed the natural contours, as to-day.<sup>1</sup> In any case it makes an interesting problem in Roman archaeology and history. Centuriation, as can be seen, was a method that was best suited to level ground, where it had its natural origin. But, nevertheless, it was also applied boldly and comprehensively in Tunisian hill-country.

An interesting feature in the centuriation at Salona lies in its lay-out on opposite sides of Kastelan Bay, with the *cardines* aligned and continued from one side of the water to the other. The ambitious scale of such an undertaking would tend to produce errors, but such errors are absent from the plan. It might be thought that the exact alignment of tall posts, 'sighted' in line, could have proved helpful at Salona, as some interesting experiments by Professor Cordingley, of the School of Architecture at Manchester University, have demonstrated.<sup>2</sup>

But it would have been possible, using the *groma* (cross-staff), to lay out the whole system of parallels *progressively*, starting from two base-lines intersecting at right-angles in the vicinity of Salona. The situation can best be compared with the laying-out of centuriation on the Carthage and Cape Bon peninsulas on opposite sides of the Gulf of Tunis (p. 199), and on promontories along the Istrian coast (p. 177). And at Salona the sighting of lines across the water for the *cardines* was very probably not necessary.

The traces of the east end of the centuriated road-grid grow progressively slighter the further we move from Spalato. This is natural, as in this part of the post-Roman landscape Spalato was the 'heart' that kept the circulation moving through the arteries. Beyond *Epetium* (now Stobrec), mountains set a limit to centuriation. *Epetium* itself was only a peregrine community under Augustus, though later it became a *municipium*, and must have had a *territorium*.

In the opposite direction, westwards, the coastal plain stretches about 13 miles from Salona, as far as *Tragurium* (now Trogir), widening out as it goes. This place was an *oppidum civium Romanorum*,<sup>3</sup> of minor status compared with a

<sup>1</sup> It is helpful to compare an aerial discovery in centuriation in Tunisia (p. 200). There we can see some blocks of Roman terraced fields which lie diagonally, in accordance with the contours and not with the axis of the centuriation square. Symmetry is, however, maintained by the straight boundaries enclosing these properties, which keep their lines parallel with the *cardines* and *decumani*.

<sup>2</sup> Prof. Cordingley kindly allows me to quote from a letter describing his experiments:—'I calculate that a pole of 2 feet diameter could be seen in conditions of good visibility, black against a light sky (or white against a dark background) at a distance of up to, if not beyond, 3 miles. I have made a great many empirical indoor tests and find that small objects can still just be seen at a distance equal to approximately 7,500 times their least dimension in the case of a white object on a black field, and about 7,000 times in the case of a black object on a white field. These tests, it is true, were carried out with the best achievable pigimentary contrasts, but in light conditions much inferior to those experienced out-of-doors, especially in Mediterranean countries. With units of centuriation of 776 yards side, as at Salona, the total length of a *cardo* crossing the Vranjica Gulf is slightly over 3 miles. If poles of 2 feet diameter could themselves be seen up to about this distance, flags on these poles could be seen at an appreciably further distance still, with the help of a breeze'.

<sup>3</sup> I wish to thank Mr. Alan Wilson for information on this and other Roman communities along the coast.



*colonia* like Salona. This stretch of coast and fertile plain<sup>1</sup> forms a zone called 'Seven Castles' (hence 'Kastelan' Bay), named from those which later defended this important shore against the Turks. It certainly formed part of Salona's *ager centuriatus*.

About one-third of the way from Salona to Trogir the cultivated coastal strip between sea and mountain grows narrower, and traces of roads and boundaries perpetuating the Roman *limites* become more scarce. The first series of air photographs which I examined came to an end about this point and it appeared that the centuriation did so too, or at least had failed to survive beyond it.<sup>2</sup> This preliminary impression was entirely wrong, as further work showed, but it provided a lesson in the extreme care which is required in photographic interpretation, and deserves a moment's consideration. In the first place, it seemed improbable that the remainder of this plain should have been omitted from the system or monopolised by a lesser place like *Tragurium*. Secondly, a calculation of the extent of the centuriated area identified up to that point, and the average individual allotments of land that it would have had to provide (according to the standards of the times), plainly showed that a much more extensive region would be needed for the foundation of a colony of such importance as Salona. Although a considerable area has been satisfactorily identified, the results could not be judged as complete.

And in fact, at a later stage, an examination of other photographs which had covered the remainder of the plain confirmed that the *limites* once again became clear and well preserved a little further to the westward! They had been kept in being by medieval peasant cultivators in Trogir and its neighbouring villages. Nor was this cultivation a sinecure. A typical entry in a chronicle (for 1538) mentions that whenever the peasants went out to work in the countryside near Salona they had always to take their weapons to defend themselves against the Turks, who had an outpost in the ruined town and who might attack them at any moment.<sup>3</sup> For centuries each of the seven villages along the coast had its own castle to ward off attacks from the interior, and the whole of the formerly centuriated area was repeatedly in the 'front line' of the Christian West. Even at the end of the 18th century the fortress of Clissa (Klis), only 3 miles up the road inland from Salona, still marked the frontier of Venetian and Ottoman territory, of Christendom and Islam. Split, like Zara and Ragusa (Plate 71 and

<sup>1</sup> (Sir) T. G. Jackson, the architect, whose *Dalmatia, the Quarnero and Istria* (Oxford, 1887, 3 vols.), contains many good observations, wrote: 'The Riviera dei Castelli is famous for the mildness of its climate and the fertility of its soil; and with the exception of Castelnovo, in the Bocche di Cattaro, it impressed us as offering the only landscape in Dalmatia which was really soft, well-wooded, fertile and highly cultivated'.

<sup>2</sup> Up to this point I had located a centuriated area equal to c. 10,400 *jugera* (6,500 acres or 31 million square yards).

<sup>3</sup> The rival Venetian and Turkish outposts are shown by Prof. Dyggve (*op. cit.*, vol. ii, 148, map),—the bare mountains and the Turks above: the coast and the seven castles below. The contrast repeated the age-old cleavage between the interior landmass and the maritime strip. Cp. Voinovitch, *op. cit.*, and H. W. Hazard, *Atlas of Islamic History*, Princeton, 1951.



and p. 273), long kept the character of 'bridgeheads' on the mainland. The old coastal civilisation of these Dalmatian ports managed to maintain itself in spite of severe pressure throughout its history.

The remains of centuriation at the western end of the Bay of Salona are preserved chiefly by minor roads, sometimes by field-boundary walls, exactly as on the Split peninsula. The coastal lowland widens out in an arc behind Divulje, a small village at about the point where the Peutinger Map indicates a little settlement. The *limites* fill this cultivated area and fit the lie of the land better than on the Split peninsula; but they stop soon after the ground begins to rise above the 100 metre contour in steep, gaunt mountain-sides. Beyond Divulje, these steep slopes come almost down to the sea, but there is a small arc of fertile cultivated land 3 miles long and up to 1 mile wide behind Trogir. This would have served the inhabitants of *Tragurium*.

It is of special interest that a set of east-west boundary lines which bisects Trogir's little plain also coincides exactly with the regular alignment of one of the *decumani* of Salona's system. The inference is that the cultivated land belonging to *Tragurium* was surveyed by the Roman *agrimensores* at the same time that they set out the *limites* for Salona's centuriation. It would have been a natural corollary.

Let us now further examine the problem of the total area centuriated. It raises some important but difficult questions.

We have no historical evidence of the total number of colonists sent to Salona. Any attempt to estimate such figures from the topographical evidence could give only general indications. But how far can it define the problem?

We may start from the fact that the Kozjak range behind Salona presents a long, continuous line of precipitous cliffs. Behind this crest, highlands of almost bare rock stretch for miles, with only very rarely a small hamlet in a *polje* where some soil has collected. Extensive cultivation is out of the question, and the same is true of the other mountainous areas which hemmed the centuriation.<sup>1</sup> Soil erosion has made them more of a wilderness than in Roman times, but would not have removed all traces of *limites* if they had existed. We can therefore set a firm geographical limit to the area that was centuriated round Salona, and we know, also, that the rocky island of Čiovo (*Boa*) at the entrance to Salona's bay shows, as yet, no signs of *limitatio*. The remains of a system on Hvar, and possible traces on Šolta, will be described presently.

Let us begin with the land that was specifically delimited. I calculate that the mainland area (exclusive of the plain behind Trogir) demonstrably associated with *cardines* and *decumani* is equal to about 100 *centuriae*, or 20,000 *jugera*. This makes a big total in millions of square yards, but it would only provide 400 settler-families with 50 *jugera* each (about 31 acres) and officials would have

<sup>1</sup> But, as I have emphasised (p. 163), the highlands must not be disregarded,—their natural resources supplied the complement to the cultivated lowland, adding the wealth of forests, hill pastures and mines, no doubt attractive to colonists. Cp. Rostovtseff, *Soc. and Ec. Hist. of the Roman Empire*, 222, 553.





46. DALMATIA, TROGIR. Traces of the grid of Roman centuriation preserved by country lanes on the narrow coastal plain behind Trogir (*Tragurium*). These remains, found from the air, are of interest because they are on the same alignment as the *centuriae* round Salona. See p. 189, and Fig. 17. Crown Copyright Reserved.



47. DALMATIA, HVAR ISLAND. Part of the plain adjoining the ancient town of Stari Grad, the *Pharos* of the Greeks and *Pharia* of the Romans. Stone walls and country roads have preserved traces of an ancient gridded layout. This vertical photo is one of a series which revealed that the basic unit of division was a square equal to  $5 \times 5$  *actus* (580 feet). Three examples are marked; many more have been discovered. See p. 191, and Fig. 18. *Crown Copyright Reserved.*





48. NORTH TUNISIA, LA MARSA, near CARTHAGE. An ideal example of a Roman *centuria* (A, B, C, D) preserved by roads in continuous use. This was a typical unit of  $20 \times 20$  *actus* ( $776 \times 776$  yards), containing an area of 200 *jugera*. Traces of regular internal divisions remain (E-F and G-H) and divisions in these same proportions have been found in other *centuriae* nearby. See p. 198. *Crown Copyright Reserved.*





49. CENTRAL TUNISIA, two vertical photos taken in the coastal sector between Chebba and El Djem, where large areas of centuriation have recently been mapped in detail for the first time. *Left* (a) Square units of  $20 \times 20$  actus. Stone field-walls (most of them retained as modern boundaries) have preserved the parallel strips of the Roman subdivisions; area 5,000 metres SW. of Ksour Essaf (SW. of Mahdia). *Right* (b) The southern limit of this system; beyond, at the top, is a zone with remains of less regular divisions on a different axis (i.e. *subsecivae*), which made use of marginal land. This region is now intensively cultivated with grain and olives; area 3,500 metres S. of Henchir ben Hassine. See p. 202. Photos by courtesy of the Institut Géographique National, Paris.



received more. As a basic lot this is reasonable by modern peasant standards, although smaller than the blocks of land that were distributed in some *coloniae*: the unit varied from colony to colony.<sup>1</sup> However, this was not the total cultivable land. Immediately round Salona is an area equal to about 20 *centuriae* (4,000 *jugera*) which shows no obvious traces of centuriation, and was probably already intensively cultivated with long-established trees and vineyards. Certainly, also, there were many other parcels of land which could have been distributed separately to individuals. One example was probably the narrow coastal strip on the south side of Mt. Marjan at the end of the Split peninsula.<sup>2</sup> It is also likely that more 'marginal' land was included in the allotments,—poor ground higher up the mountain slopes. There is some evidence, from the air photographs, which may support this. At one or two points along the seaward face of the Kozjak Mts. fairly extensive remains can be seen of ancient (now abandoned) cultivation-terraces supported by stone walls. These lie more than half-way up the steep slope, beyond the limit of centuriation's traces and below the vertical cliffs on the upper part of the mountain side. Great numbers of very large stone heaps show that these terraces were cultivated at enormous pains for a long period, and a Classical origin seems quite possible. The individual plots are very small but very numerous, fitted perfectly to the contours. Archaeological field-work is clearly required. Here and there is a small patch, easily distinguished, where a modern peasant has begun cultivation again, levelling the old small terraces and making much bigger plots.

To what extent, too, did Salona's *territorium* extend inland and southward?<sup>3</sup> These questions will serve to show the preliminary difficulties in attempting any analysis of land-settlement even when the extent of the *ager centuriatus* can be accurately defined.

Some 20 miles south of Salona, and north of 'Black Corcyra', lies the island of Hvar (Fig. 18), called by Italians Lesina. My study of war-time air photographs showed that the plain adjoining the port of Stari Grad in the north-west of the island was covered by remains of an ancient grid of roads and boundaries. These enclose squares which measure 585 feet across or exactly 5 *actus*, in area 12½ *jugera* (Plate 47).

The existence of these 5 × 5 *actus* squares is decidedly interesting and unusual. Hvar can show archaeological material from almost all historical periods, and there is evidence that some settlements have been occupied since prehistoric times. The island was named Paros or Pharos by the Greeks, and it is generally

<sup>1</sup> Prof. Fraccaro considered that even 30 *jugera* was a possible unit of allotment at Pisa ('La Centuriazione romana dell'Agro Pisano', in *Studi Etruschi*, XIII, 1939, 226) and Dr. Castagnoli is ready to consider 50 *jugera* as the basic lot at Florence (*L'Universo*, July-August 1948).

<sup>2</sup> There are some patches of suitable ground on the mainland coast opposite Brac which also have to be considered.

<sup>3</sup> On this question see Patsch, in *Wiss. Mitteil. Bosnien und Hercegovina*, vol. vii (1902), 86; the map on taf. ix shows interesting evidence of the Romanised countryside between Salona and Naronia to the south, in the area of Imotski (*Novae*). Cp. Patsch, *ibid.*, ix (1904), xii (1912).

agreed that it was colonised by Parians early in the 4th century B.C. More than one Greek town grew up:<sup>1</sup> that named Pharos seems to have been at or close to the site of the present town of Stari Grad (Citta Vecchia).<sup>2</sup> Hvar with its 12th century cathedral is now the largest town (3,000) but Stari Grad (2,500) was formerly the more important. The island was added to Rome's possessions in 219 B.C., when Demetrius of Pharos was driven out. The town of Pharos continued active in the Roman period but we know very little of its history or status,<sup>3</sup> and we

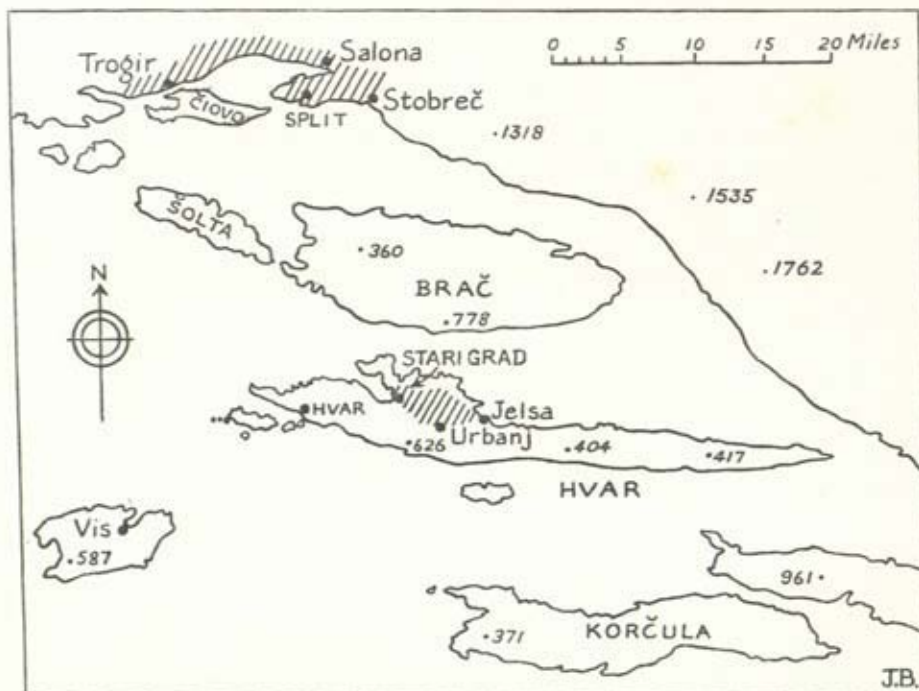


FIG. 18 Dalmatia. The area covered by the ancient grid of roads ( $5 \times 5$  *actus* squares) on the island of Hvar, discovered from the air, in relation to the zone of centuriation found at Salona. See Plate 47 and p. 191.

receive no indication that one of the best preserved systems of centuriation so far known can be seen here.

Hvar is one of the more densely populated of the islands. The scenery is magnificent, the climate excellent and milder than the mainland. The cold 'Bora' blowing from the north, weakens off the coast,—so that winter wind-frequencies are only 2 on Vis and 4 on Hvar as compared with 26 at Sibenik on the mainland. But it requires a safe natural harbour combined with an

<sup>1</sup> Silver coins of the 4th century are identified as having been struck at Pharos: S. Casson, *Macedonia, Thrace and Illyria*, 1926, 316-18. Cp. also G. Novak, *Prehistorijski Hvar*, Zagreb 1955.

<sup>2</sup> Pauly-Wissowa, *Real-Encycl.*, art. 'Pharos', 1938; R. L. Beaumont, 'Greek Influence in the Adriatic', *Journ. Hellenic Studies*, 1936, p. 188.

<sup>3</sup> Cp. *C.I.L.*, III, pt. i, p. 394. Inscriptions from Stari Grad and Verbanj. Also III suppl., pt. i, p. 1646.



adjacent fertile plain in order to complete the ideal prescription for classical (and indeed modern) well-being. On Hvar these conditions are only fully satisfied at Stari Grad, where there is a sheltered bay with deep water close inshore; this bay narrows to form a small secure port where the building of small coasting vessels is still of local importance. A mountain spine runs the whole length of the island, but between Stari Grad and Jelsa (which also has a good little harbour) a very contrasting type of relief is found,—a level plain land-locked between hills to north and south.

This plain has rich soil, admirably productive of vines, olives and various fruits. A study of the other adjacent islands<sup>1</sup> confirms that this plain is the best that any can show, and no doubt was well known for its fertility before the Roman centuriated grid was laid down. The remains of the *limites* (Plate 47) cover an area about 5 miles long and up to 2½ miles wide, with an old port at opposite ends (Stari Grad and Jelsa), and villages which were occupied in Roman times on its margins (e.g. Verbanj). The *limites* have chiefly been preserved by stone walls; some gaps occur in their lines as the result of age-old use, but, on the whole, continued cultivation has kept them in very good shape. Their axis is orientated north-north-east to south-south-west. The need, now, is for fieldwork on the ground, to follow-up this discovery. The status of this system and its Roman owners poses a good historical problem.

### TUNISIA

In the province of Africa the centuriated landscapes show the dynamic imprint of Romanisation even more clearly than do many of the systems in the homeland. No other province was partitioned in such wholesale fashion. Even in southern France where the legacy of Romanisation survived effectively no more than a few scraps of centuriation are recoverable; Dalmatia is a richer field as we have seen. But in Tunisia after a thousand years of Islam the grid of Roman roads on the Carthage peninsula is still used today almost as much as it ever was,—and, further south, mile after mile of deserted Roman fields lie open for all to see and for enterprising modern colonists to resurrect and recultivate, if they follow the evidence of their own eyes. This general picture has long been familiar, since the work of Schulten and Barthel. Subsequently for many years progress was slow.<sup>2</sup> But during the last few years a vast amount of new material has been discovered and is still not yet assimilated fully.

<sup>1</sup> Examination of the post-war A.M.S. 1 : 50,000 maps, revised from war-time air photos, has shown traces of regular division, possibly ancient, on the island of Šolta (*Solentia*), (see fig. 18), on the cultivated area of plateau and polje at the centre (round Grohote).

These maps show no traces of *limitatio* on the island of Brač, or on Vis.

<sup>2</sup> Earlier sources include Schulten, *Bulletin Archéologique*, 1902, 129-73; Barthel, *Bonner Jahrbücher*, CXX, 1911, 39-126; Gsell, *Histoire ancienne de l'Afrique du Nord*, esp. vol. VII, 1928; Broughton, *The Romanisation of Africa Proconsularis*, 1929; *Atlas Archéologique de la Tunisie*, 1 : 50,000, 1892 onwards, with supplements 1 : 100,000.



This accelerated tempo in the study of Tunisian centuriation is, of course, a by-product of the French programme of aerial revision of the ordinary civil maps since 1947, although photographs taken 20 years earlier had given us general indications of how much was awaiting discovery.<sup>1</sup> Thanks to the kindness of M. Saumagne (formerly Secrétaire-Général Honoraire du Gouvernement Tunisien) and of M. Horlaville (Ingénieur en Chef Géographe de l'Institut Géographique National) I was able to keep in touch with the progress made and to examine representative photographs. But before this I had already begun an independent study which started in 1943 while serving in Tunisia, and which was based on the use of British air photographs taken at that time. Many of these recorded fine views of the remains of Roman agriculture. Other parts of North Africa cannot rival Tunisia as an area for the study of centuriation, although many important remains of Romanised irrigated cultivation have been discovered by air photography in Algeria and Libya in recent years. No systems of true *centuriatio* have been reported from these areas by either Colonel Baradez<sup>2</sup> or Mr. Goodchild, in spite of extensive archaeological survey.

The fresh archaeological facts present a lifelike, homogeneous and faithful picture of great areas with a profusion of detail. New systems of *centuriae* can be seen, particularly in the southern half of Tunisia; and their continuation over the area of Cape Bon has been securely mapped for the first time. The subdivisions inside the *centuriae* and the tree-pits inside those subdivisions can now be seen in inexhaustible numbers, besides the local settlements large and small which peopled and farmed the landscape. Inevitably the picture that now confronts us is very much more complete and elaborate than that which Schulten and Barthel obtained from the French maps of 50 years ago. The advance can be seen when we compare, for instance, Barthel's map (Taf. V) of the *limites* in the Mahdia-La Chebba coastal area near El Djem with the latest archaeological maps (1 : 50,000) printed by the Institut Géographique National and based on air survey. The former shows some scattered fragments, the latter great zones of several hundred square miles covered by continuous *limites intercisivi*, positioned from vertical photographs. We are faced with an entirely new situation,—for as Schulten himself emphasised, it was impossible to make accurate measurements of *limites intercisivi* on the old maps of 1 : 50,000 scale prepared from ground survey alone. Such *limites*, which consist of banks only one to two metres thick were represented on the maps by lines which greatly exaggerated their width. Further, when the new evidence is examined,

<sup>1</sup> Cp. M. Charles Saumagne, in *C.R. de l'Acad. des Inscr. et Belles Lettres*, 1929, 307-13,—a preliminary report followed by a detailed account, *ibid.*, 1952, 287-301. M. Horlaville has described the centuriation found on Cap Bon, and the Institut Géographique National has also issued a booklet (by M. Caillemer) on *Les Centuriations Romaines de Tunisie* (Paris, 1954), and is producing excellent maps of 1 : 50,000 scale, over-printed with the aerial discoveries.

As a postscript after this book had gone to press, I am glad to add that the Institut Géographique National has published an *Atlas des Centuriations Romaines de Tunisie* with maps at 1 : 50,000.

<sup>2</sup> One of Baradez's air photos (*op. cit.*, pl. 178) shows a block of fields regularly divided, apparently local *limitatio*.



some of the opinions based on the partial picture given by these earlier maps have to be radically emended,—as in the case of the alleged division by the land-units termed *scamna* and *strigae* (p. 201), which Schulten had claimed.

To sum up briefly. As the result of the new data, (i) fresh systems have been mapped, (ii) known systems have received very extensive additions, (iii) our picture, *from the soil*, of cultivation and subdivision inside the *centuriae* has been enriched by a mass of facts. This last is probably the most crucial advance.

Some of the details shall be set forth presently. Meanwhile it may be noted that we have not, by any means, reached an end of the aerial discoveries of centuriation to be made in Tunisia. But topographical study cannot advance beyond a certain point without excavation, particularly at selected farms and settlements in the newly mapped areas. Imprisoned in the soil is a mass of economic, social and chronological data which we must have. The thorough investigation of these systems as we now see them could easily absorb the life's work of several archaeologists. Not, of course, that this material is of limited or specialised value,—or the concern of students of ancient agriculture only. It becomes the direct concern of the historian,<sup>1</sup>—a source to be assimilated and used, and one that adds substantially to the ancient texts.<sup>2</sup> When it equips us with so full a record, the air photograph ceases to be an auxiliary instrument of research and becomes a document of much greater power. Weighing his words with care, M. Saumagne writes thus of its contribution in Central Tunisia:—  
'Avec une impartialité mécanique et une incorruptible probité, elle recrée . . . une véritable source originale de l'information historique. Un assemblage rigoureux des vues qui reproduisent, par exemple, les centuriations du Sahel, doit être étudié en lui-même et pour lui-même, de la même manière que le serait une table de bronze ou de marbre, une membrane ou un papyrus que nous auraient livrés les archives domaniales de l'Empire romain, et qui porteraient comme en forme de palimpseste les images successives des variations d'une même histoire agraire et sociale.' This is equally true of the 'dead' systems of centuriation in Apulia discovered from the air in 1945. Photographs of these gave as detailed a picture of the practical working of Roman methods as those

<sup>1</sup> 'En Afrique, la centuriation apparaît comme le régle d'or permanente de la discipline agraire et financière de Rome. Dès les années 146, 122, 111 av. J.C., son application massive assure à jamais la mise en ordre de toute la propriété foncière dans l'*Afrique Vetus* et sa distribution aux colons de la *Colonia Iulia Karthago*; des 44 av. J.C. et jusque sous le règne de Tibère, elle absorbe tout le territoire de l'*Afrique Nova*. Elle est au coeur des grandes révolutions agraires qu'illustrent le *lex manciiana* et la *lex hadriana*; elle conditionne au long des III, IV et V siècles, les lois de fiscalité du code théodosien et la doctrine des *gromatici*; au VI siècle, elle est vivante dans la législation justinienne'. Saumagne, *op. cit.*, 1952, 289. In this region the *centuria* was used in assessing taxation, Deleage, *La Capitation du Bas-Empire*, 230.

<sup>2</sup> There are only a few brief references in the writings of the Roman surveyors that concern centuriation in Africa. Schulten has collected them (*op. cit.*, 171-2), but they are not very helpful. He concludes: 'Certes, ce sont là des renseignements assez pauvres, et on donnera la préférence aux documents d'arpentage fournis par le sol de l'Afrique lui-même'.

For inscriptions on the boundary *termini*, so important in the south, cp. Barthel, *op. cit.*, 60 seq.; for appropriate references in classical historians, cp. R. M. Haywood, 'Roman Africa' in *Economic Survey of Ancient Rome*, vol. IV, 1938 (ed. T. Frank).

taken in Tunisia,—and thus a very detailed ‘control’ is now available on *both* sides of the Central Mediterranean for the study of cultivation under conditions of centuriation. Clearly, ‘dry farming’ in Roman Tunisia is in many respects specialised, but with a method as formalised as centuriation, and as instinct



FIG. 19. Reference map to show the localities mentioned in the account of centuriation in Tunisia.

with Roman practice, there is much that has relevance to the study of other contemporary systems.

At present, however, we are not yet ready to marshal all the new evidence for a comprehensive review of centuriation in the province as a whole,—and instead, in the present account, it will be best to proceed gradually, and to outline some few of the facts in the more complex picture which is emerging.



*Northern Tunisia*

(a) The remains of a famous system, a homogeneous block, covers a great rectangle from Bizerta in the north-west corner to Enfidaville in the south-east (a distance of 150 km.), and from Cap Bon in the north-east to the Siliana river in the south-west (180 km.). The area totals about 15,000 sq. km., and the *centuriae*, which are 200 *jugera* units, keep within the line of the *Fossa Regia* that bounded the *Provincia Africa* created after the conquest of 146 B.C. This *limitatio* belongs to the first phase in opening-up the country to Roman administration. There is general agreement that it is intrinsically associated with the partly abortive foundation of the Gracchan colony in 122 B.C.<sup>1</sup> Without doubt this event must have brought the matter to a head. But the centuriation of this whole region of north-east Tunisia could not have been completed in a year or two. It is plain that progress had been made before this date; Gsell and other authorities agree that the first steps were taken in 146-5, when the senatorial commission was sent out. Traces of the *centuriae* round Carthage, Medjez el Bab, Soliman, Grombalia, etc., have long been known, but air archaeology has filled-in very many details and has demonstrated for the first time the particulars of the lay-out on Cape Bon and other little-known areas.

Archaeologically, one of the most impressive results is the importance which soil and vegetation markings have suddenly assumed. They reveal the lines of the stony banks which bordered the Roman fields, and which time and recent ploughing have levelled. Many other such boundaries survived above ground, only awaiting 'total mapping'. Earlier descriptions, even Barthel's, told us little or nothing of these *limites intercisivi*. In short, this system—which has been so often discussed in the past,—can now be shown to be replete with new archaeological facts.

(b) On the western edge of the system mentioned above, traces of centuriation with a difference in orientation have been reported by M. Caillemer<sup>2</sup> as being visible within the area of the Teboursouk 1 : 50,000 map sheet. Intervals of about 20 *actus* are said to be visible. This area would have stood outside the boundary of the *Fossa Regia* which here approximately followed the Siliana valley a little to the east.

System (a) covered much hilly and wooded country, and is one of the finest systems of its kind ever built. Details can be added even to the famous *centuriae*

<sup>1</sup> For the historical background to the foundation of *Col. Iunonia* only 23 years after the solemn curse laid on Carthage, cp. Carcopino, *Autour des Gracques*. The anti-Gracchan party in the Senate, fearful of the new colony, had it suppressed in 121 alleging evil auguries at the leading-out ceremonies and such sinister portents as the uprooting of the boundary posts by jackals. Gsell's account of the whole episode is very good (vol. vii, 64). The original plan was to send c. 6,000 colonists; a good number arrived and remained, as shown by the *lex agraria* of 111. Schulten's calculation that an area of only 100 *centuriae* was available for distribution is now obsolete.

For the revival of the site as *Col. Iulia* in the second half of the 1st century B.C., see p. 236.

<sup>2</sup> He states that the *limites* are inclined at an angle of 28 grades (25° 12') not 32 grades (28° 48') as in the adjacent system that stems from Carthage.



on the Carthage peninsula which were first found by Captain Falbe, the Danish Consul at Tunis, who published his exemplary observations as long ago as 1833;<sup>1</sup> and I shall take one *centuria* as a superb 'text-book' example to demonstrate several points (Plate 48). It adjoins the coastal village of La Marsa, a mile or two north of Carthage. This area is cultivated with corn and with vegetable gardens irrigated by channels from cisterns supplied by wells, as it would have been when it served the populous Roman *colonia*. The existence of wells and cisterns does much to stabilise a field pattern. The country roads have continued to preserve the outlines of many of the *limites* where these were of practical use, but some later trackways have brusquely taken a more convenient route across them. The old track which runs diagonally across the *centuriae* on Plate 48 linked La Marsa (a burial place of 13th century sheiks) to the village of Malga, the focus of medieval occupation at Carthage. On Plate 48, the line of the road B-C represented that of the *Decumanus Maximus* of the whole system according to Schulten but Barthel regarded it as the *Cardo Maximus*.<sup>2</sup> It was certainly a main axis, for outside the peninsula the tenth parallel road to the south passes the ruins of the site of *Ad Decimum* at the village of Fath Allah. On the peninsula the squares are divided by many straight boundaries and some (e.g. E-F, G-H) still preserve remains of the regular division by *limites intercisivi*. Viewed from the air this may appear obvious enough, but I myself, having spent several months at this very spot, can vouch for the fact that little impression of the regular subdivisions is obvious from eye-level. In any case, when considering a landscape in active use it is always a serious problem to decide how far one can safely assign an ancient origin to the field-pattern. Fortunately this is one of the few instances where confirmatory evidence can be demonstrated. Not far distant there are areas of 'dead' *centuriae* on land untouched by modern cultivation, and these we can use for control and comparison since details of their internal layout have now been recorded by air survey. Thus, when examining the squares on the Carthage peninsula, I noticed that a number of them showed traces of a division into five equal bands parallel with the north-west to south-east lines of the grid. Some of these divisions were traceable more or less continuously through three or four consecutive squares—i.e. for a distance of  $1\frac{1}{4}$  to  $1\frac{3}{4}$  miles; the same feature is also noticeable in some of the North Italian systems. Fortunately it is easy to show that at Carthage these subdivisions were not the work of recent cultivators but were of Roman derivation, for the air photographs record the same method of division in areas of untouched Roman

<sup>1</sup> *Récherches sur l'emplacement de Carthage*, Paris, 1833. This resourceful naval officer produced one of the very first systematic archaeological maps of a centuriated landscape. He worked under grave difficulties, with a small pocket sextant which could only be used in deserted spots because of 'curieux fanatiques' and a government 'inquiet et jaloux'.

<sup>2</sup> The absence of inscribed boundary stones handicaps attempts at identification. Even where boundary stones exist, as in south Tunisia, the differentiation of *cardo* from *decumanus* depends on the correct interpretation of what was intended locally by the terms *dextrata*, *sinistrata*, *ultrata* and *citrata*; e.g. on the stones which signify positions *sinistra decumanum*, *kitra kardinem*, etc. Cp. Barthel, *Bonner Jahrbucher*, 1911, 96 and 125 (discussing the views of Toutain) and Pauly-Wissowa, *Real Encycl.*, art. 'Limitatio'.



fields outside the peninsula (p. 200, *e*). Some squares that have remained in constant use are now divided by three strips of regular width in the proportions 2 : 1 : 2 (compare Plate 48, E-F, G-H). Probably they are remains of an original division into five or even ten strips, which have a natural tendency to coalesce when preserved in a living landscape.

A comparative study of the *limites intercisivi*, based on the contrasted degrees of survival visible in Tunisia, is particularly instructive when we try to assess the survivals of such boundaries in North Italian and other systems. In Tunisia we can estimate, with an unusual measure of confidence, the extent of the schematisation and simplification that has gone on in the living landscape.

The chief additions to our knowledge of the great system that covered the north-east of the country have come naturally from the large areas in which cultivation later declined or disappeared. For example M. Horlville has been able to find extensive remains of centuriation all over Cap Bon, except on the steepest parts of the central mountain spine and on the hills behind Nabeul. The orientation is the same as on the Carthage peninsula, and the units are squares of 200 *jugera*. These traces were not clear when the south part of Cap Bon was surveyed about 1890, for it was mostly covered with woods and scrub, and although much had been cleared by the time of the 1931 revision the surveyors on the ground, even then, only recorded some of the most obvious Roman sites. It was left to air photography in the last few years to make evident the mass of trackways, low earthworks, soil-marks and vegetation-marks which represent the Roman road-grid and the accompanying divisions inside the squares.

In the western and southern parts of this system (e.g. on the Zaghouan and Bou Arada 1 : 50,000 map sheets) the discoveries have been equally detailed. A point of interest is that air photographs have shown how extensively *limitatio* was applied to very hilly ground. On the hills of the Djebel Mansour and Djebel Fkirene, for example, its remains sometimes continue as far as the 1,600 foot contour.<sup>1</sup> The centurial road-grid goes on steadily across deep valleys, involving a skilful and ambitious use of survey in rough country. Besides the considerable remains of Roman field-banks, there are also the markings made by rows of buried tree-pits in plantations, and of numerous farms and settlements not previously recorded. Some of the farms stood near the middle of the squares, but most of them were close to the road-side. One naturally hopes that the topographical evidence will help throw light on the arrangement of the *saltus*, estate farming. Possible hints are given by traces which lie within the Bou Arada and Oued Zarga map sheets. It is reported that there are blocks of *c.* 25 *centuriae*

<sup>1</sup> Fine remains can also be seen on Dj. Rihane (Bou Arada map sheet), over which natural woodland has grown. But some hilly areas have no traces, e.g. round Oudna; in such areas there was only an isolated *cardo* or *decumanus* which maintained the orientation of the grid when passing from one side of a mountain to the other (e.g. Dj. Zaghouan).

It is particularly impressive to see, on the air photos, an enormous quantity of regular *limites intercisivi* covering areas of bare hills now almost destitute of cultivation in the neighbourhood of Medjez el Bab.



carefully partitioned internally, which are surrounded by a zone of fragmentary *centuriae* showing few if any subdivisions. True, those differences may prove to result from environmental causes or the effects of modern agriculture. But it is worth investigating the possibility that such an area may represent a *saltus*, with its surrounding land perhaps for grazing. It would be interesting to try to correlate the data from the photographs with the known estates in Tunisia, discussed by Broughton and by Haywood.

Meanwhile, the analysis and mapping of the traces of Roman fields inside the squares are providing as much new evidence as can be studied conveniently.

The methods included:—

- (a) A division into four quarters, i.e. squares of 1,200 R. ft. side.
- (b) These quarters could be divided by ten strips, 120 R. ft. wide.
- (c) These strips were sometimes crossed by others of the same dimensions, thus forming plots measuring 120 R. ft. square (1 square *actus*).
- (d) Or these strips might run the full length of a *centuria*.
- (e) Alternatively they might be twice as wide (240 R. ft.), equal to one-fifth of a *centuria*,—like those divisions still preserved in the modern fields on the Carthage peninsula.
- (f) Most interesting of all, the fields were occasionally aligned in strips to follow the line of the slope, if steep. That is to say, the divisions were 'contoured' and *not* at right angles to the *limites*,—producing a terraced effect.<sup>1</sup> But, in such cases, the area covered by these heterodox diagonals was still enclosed by regular boundaries to form a definite number of *jugera* or *actus*. In this manner individualism was kept within bounds.

### *Central Tunisia (the Sahel)*

Some of the most notable additions from aerial survey have been made on the coastal sector of central Tunisia, on the lands of the old free towns along it,—*Hadrumetum* (Sousse), *Leptiminus*, *Thapsus*, *Acholla*,—which supported Rome in the final conflict with Carthage and were confirmed in their territories in 146 B.C. This centuriation lies inside the line of the *Fossa Regia*<sup>2</sup> and covers the southern portion of *Africa Vetust*. But it is generally believed to be over a century later in date than the Carthage system which filled the remainder of that province. A strong case has been made for assigning its construction to the Augustan era.<sup>3</sup> Barthel considered that it was essentially part of a second great centuriation in Tunisia which he envisaged as based on a single pair of vast axial lines covering the new lands to the west and south embodied as *Africa Nova*

<sup>1</sup> Cp. Saumagne, *op. cit.*, 1952, fig. 1.

<sup>2</sup> This ran from north-west to south-east, from *Thabraca* on the north coast to *Thaenae* below Sfax on the east coast.

<sup>3</sup> The arguments are well expressed by Gsell (*Hist. Anc. de l'Afrique du Nord*, vii, 14, n. 3). He concluded 'La question ne peut être actuellement résolue'. Now, of course, it could be resolved finally,—by excavating selected farms and other sites revealed along the *limites*.



(created in 46 B.C.) and embracing this southern portion of the old province in addition; its completion was spread over a long period from Augustus to Tiberius.

The monolithic simplicity of Barthel's analysis has been modified a little by evidence supplied by air archaeology. For example, in actual fact, this central coastal sector contains not one but *two* large blocks of centuriation, with different orientations. A non-centuriated zone separates them.

(a) Let us first examine the northern of these, which has a coastal front of 120 km., from Hergla (north of Sousse) to a point just south of Chebba,—and an average depth of at least 20 miles.<sup>1</sup> As Barthel showed,<sup>2</sup> its northernmost line of *centuriae* impinge on the southernmost of the older system in the northern part of *Africa Vetus* that stems from Carthage. The air photos confirm this fact and also the difference of 8 degrees between the orientation of these two systems.

In this Sousse-Chebba region the chief result of the new evidence from 'total mapping' has been to bring a revolutionary advance in the detailed picture of the system.<sup>3</sup> The pattern of *limites intercisivi* is now so dense in some areas,—particularly round Chebba,—that when their lines are mapped at a scale of 1 : 50,000 it is difficult to put down the point of a pencil without touching one of them. Increased knowledge of the subdivisions inside the *centuriae* has clarified a number of problems which are of more than local importance. To take an example: Schulten<sup>4</sup> claimed to see traces of a rare type of survey by the rectangles called *scamna* and *strigae* at El Alia. But in truth these are not units of a special lay-out, but only normal subdivisions inside ordinary 200 *jugera* squares, as can at last be seen now that they are fully mapped.

Schulten's error was not surprising, for a great variety of subdivisions has now been displayed. Behind Ras Salakta on the coast there is a group of *centuriae* in which the internal divisions were laid parallel with one axial line only; i.e. in ten strips from north-east to south-west (Plate 49a). Elsewhere, some squares are divided 10 × 10, making one hundred plots of 2 *jugera*. An even more common division is by five strips in one axis and by ten in the other,—making fifty rectangles of 480 × 240 R. feet (plots of 4 *jugera*) within the square. We also find plots of 8, 12 or 16 *jugera*; and some of very small size, only 1 *actus* (120 R. feet) square. Some of the smallest may be the product of various economic causes in Roman times (the pressure of a growing population, or inheritance). But the symmetry and lay-out of many of them prove that small subdivisions were long-established. In any case, the construction of small embanked fields

<sup>1</sup> Remains of *limitatio* have been found from the air as far as the line of the marshes of the Sebkha Kelbia—Sebkha Sidi el Hani—Sebkha el Djem from north to south. Further examination of air photographs should settle the problem of its continuation into the interior, in order to confirm Barthel's thesis.

<sup>2</sup> *Op. cit.*, taf. III.

<sup>3</sup> The air photos should also be able to add to our knowledge of the camps built by Caesar and by Juba during the campaigns in the Sousse-Chebba area, described in the *Bellum Africanum*.

<sup>4</sup> Schulten, *op. cit.*, 164-5 and pl. X.



played a vital part in anti-erosion measures and in water-conservation policy. These field-banks, of stones and earth, still stand to a height of several feet. Although crumbled they have lasted well, and in the plan-view from the air the areas of dead fields almost appear to be living cultivation.

A good selection of *limites intercisivi* is shown on Plate 49a,  $4\frac{1}{2}$  to 5 miles inland and west of Ras Salakta, *Sullectum* (cp. 1 : 50,000 Mahdia sheet). The Roman road from *Sullectum* to *Col. Thysdrus* (El Djem) can be seen as a straight line, oblique to the axis of the squares. This area is under cultivation with corn and olives today; great numbers of Roman field-banks have been retained in use, or are still visible. The ground is level, dissected by wadis; some of these the *limites* crossed, others halted their path. Scattered over the area there can be seen some half-dozen whitish patches,—the sites of Romanised settlements. In some zones their remains are even more numerous. The scale of the photograph is 1 : 25,000. This may seem a small scale, in terms of archaeological use (p. 58). But it will be seen that it does give a clear picture of all that is essential; even individual olive trees can be identified and counted. It is, in fact, an ideal scale for a survey of extensive Roman agriculture in a region of this kind.

The next illustration, Plate 49b (scale 1 : 25,000), is 9 to 10 miles south-west of Chebba on the coast, and  $2\frac{1}{2}$  miles south of Henchir ben Hassine.<sup>1</sup> It covers an area at the southern edge of the coastal belt of centuriation which we are discussing, and which ends on the borders of a natural basin where the terrain changes (p. 204). The squares are those of 200 *jugera*, and numerous *limites intercisivi* survive. The small black patches on the photograph represent freshly-dug ground,—the white patch near the centre is the site of an ancient village which coincides with a modern one. Almost all the field-boundaries have an ancient origin. But the point of chief interest on this photograph consists in the junction of the system with an area of boundaries on a different axis. These latter boundaries impinge on the grid, but they do not have the same orthodox symmetry,—they are utilising the land that is marginal to a large system in a frugal and practical manner. In short, they represent that type of land described by the *agrimensores* as *subseciva inter perticas*, which ensured that there was no wastage. In some areas, within the system itself, small patches of irregular *limitatio* were superimposed on the regular *centuriae*, and these are obviously of later date (how much later we do not know); in some instances they may be connected with estates. Cultivation in this region had a long history, and 'laissez faire' in the period of the late Empire and after must be reflected in the remains. A hypothesis of centuriations of different dates is eliminated by the varying orientations of these interpolations. I have laid emphasis on the *limites intercisivi* in this section because (except in Apulia) it is only in Tunisia that we can extract so informative a picture of Roman land-utilisation against a background

<sup>1</sup> Saumagne calls attention to the site of an ancient town, still un-explored, at this spot. Pottery gives evidence of a long occupation, Roman (or earlier) to medieval Arab. Sheet LXXXII, Chebba.



of centuriation. Much could be written in analysis of the details of lay-out; and not all of this topographical data is easy to interpret.

Thus we come to the subject of land use in the past. But first we must consider the topographical conditions. The region of the Sahel lies on the eastern edge of low steppe. In many areas modern cultivation has only recently begun to spread over the remains of the dead agricultural systems which in parts had been virtually derelict for a thousand years. In the last few years plantations of olives have covered great areas, and, as the landscape quickly takes on a new life, many of the Roman field-boundaries will be erased. The air photographic record, indeed, has come only just in time.

The climate has not changed materially since Roman times, as far as can be judged. The clearing and deforestation which accompanied these systems evidently proceeded slowly enough for the results of 'sheet erosion' to be seen and for precautions to be taken before much harm resulted.<sup>1</sup> The Roman fields and olive-presses which are found in inland areas that have now reverted to natural forest, and also on steep slopes, signify a clearance which would have brought some erosion as a consequence, but the development of gullies and ravines was probably reduced to less than in pre-Roman times by hydraulic works, and by the careful cultivation and control of the wadis on the plains by the centuriated systems, as we can see. The Arab conquests of the 7th century were on a small scale compared with the terrible ravages of the 11th century<sup>2</sup> when complete tribes descended on the ancient and somnolent agriculture of the Sahel. Pastoralism steadily increased at the expense of cultivation; security for farmers dwindled. One can summarise by saying that in the Arab centuries the conditions returned to the natural erosion of pre-Roman times. Scrub grew up on the deserted areas and checked erosion, but the development of ravines and gullies was increased because Roman precautions were abandoned. Formerly the fields had been deliberately embanked, and banks bordered the wadis in the centuriated systems; these required attention and when unattended they could no longer preserve the balance. In modern times when agriculture has returned to many areas,<sup>3</sup> few precautions were taken and erosion grew rapidly. It was only after several bad seasons and heavy rains that some cultivators determined to copy Roman methods. The population of Tunisia, now over three million, has more than doubled in the last fifty years with a new-found security, but is probably still below its total in the best Roman period.

From this brief review of the character of the region we can return to consider

<sup>1</sup> Cp. 'Conditions historiques de l'érosion en Tunisie', by J. Tixeront, *Union Géodésique et Géophysique Internationale*, Bruxelles 1951, tome II, 73-81.

<sup>2</sup> I.e. the invasion of the Arab tribes of the Banu Hilal. For conditions in medieval Tunisia see Marçais, *Les Arabes en Berbérie du XI au XIV siècle*, 1913, and R. Brunschvig, *La Berbérie Orientale sous les Hafsides*, vol. i, 1940.

<sup>3</sup> Shortly after French authority was established at the end of the 19th century in Tunisia, the creation of the forest of olive trees round Sfax was directly inspired by the numerous visible remains of Roman olive oil presses to be seen in the area, uncultivated at that time.



its ancient aspect more fully. It is well-known that Central and Southern Tunisia became very important areas of olive-cultivation in Roman times.<sup>1</sup> The air photographs, I think, define this fact more clearly than ever before. The evidence comes from the plantations which we can trace from the markings caused by regularly spaced tree-pits. The vast majority of these were undoubtedly for olives, although figs too were grown. Tree-pits were needed to penetrate a layer of soft tufa just under the surface soil, and any moisture was thus drained off into the holes. This was the only way to establish young tree-cuttings;—*in scrobibus posuerit* as the Ain el Djemala inscription says.<sup>2</sup> Elsewhere I have described<sup>3</sup> the rock-cut tree-pits in Roman plantations which we discovered from the air in the Apulian centuriation in S.E. Italy, and excavated there. In Mediterranean lands it remains, of course, the modern practice to dig such tree-pits in a rock sub-soil, and I have measured examples with the same dimensions as those of Roman days (*c.* 1 metre square) at Les Baux in Provence, in Apulia, Sicily and in Greece. In Tunisia, the additional depth of soil in the ancient tree-pits causes a vigorous crop- or grass-marking above each one in any rainy season, contrasting with the tint of the surroundings. It is evident that the Roman farmers planted their olive trees nearly twice as close together as is the practice of their modern successors. We can count 4 to 5 tree-pits to the square *actus*, ten to the *jugerum*, and a completely planted *centuria* could, in theory, contain 2,000 olive trees. The total area that was demonstrably cultivated in this way is vast, but not all the plantations would have been in use at one date.

Now is the time to plan the full extent of these Roman olive-groves, before the modern ones, now being planted on a large scale, blot out the ancient traces.

(b) On the southern edge of the system described in the last section there is a broad natural basin or depression which runs inland from the sea. This area was anciently cultivated but not centuriated.

South of this again, yet another grid has now been found. It is of special interest that it has a different orientation from that to the north of it.<sup>4</sup> This new system is well seen in the area of Djebeniana. The squares are of 200 *jugera*, and at least 300 of them have been reported by M. Caillemer. Many traces of the *limites* can be seen on the 1 : 50,000 maps,<sup>5</sup> and I have traced their remains for

<sup>1</sup> Especially the broad centuriated zone along the coast. Warmington states that olive-cultivation increased rapidly in the 2nd century A.D., *The North African Provinces from Diocletian to the Vandal Conquest*, 1954, 56-7.

<sup>2</sup> *C.I.L.*, VIII, 25943; and Haywood, *op. cit.*, 94-5.

<sup>3</sup> *Antiquity*, June 1950, p. 90.

<sup>4</sup> In the Sousse-Chebba zone the *limites* are inclined at an angle of 42 grades (nearly 38 degrees) from the meridians. Those around Djebeniana are inclined at an angle of 32 grades (29 degrees), i.e. W.N.W.-E.S.E. and N.N.E.-S.S.W. The axes of the Carthage system also make an angle of about 29 degrees from the meridians but have an entirely different orientation, N.N.W.-S.S.E. and W.S.W.-E.N.E.

Such orientations were taken from the sun's position on the horizon, at its rising or setting, at the summer or winter solstice.

<sup>5</sup> Sheet XC, Djebeniana and XCVIII, Sidi Salah.



12 miles in the zone bordering the coast. The photographs, however, make it possible to add a very large number of *limites*, from small field-boundaries which the maps naturally omit.

The existence of a differently orientated grid in this part of south-central Tunisia proves a notable exception to the two basic lay-outs on which, it was believed, all centuriation in the country was founded. The orientation of this system is completely different from that round Sousse or Carthage.

The southern and western limits of this system are not yet certain, but eastwards towards the coast it is said to be defined by the remains of long sectors of ditches, which M. Saumagne describes as *c.* 15 metres wide, and up to 6 metres deep (reinforced with a stony bank and masonry bastions); he adds that these ditches seem to surround two areas each dominated by the ruined site of a coastal town: one believed to be *Acholla* (at Ras Bou Tria) and an un-identified *emporium* at the spot named Rosfa (? *Ruspe*). Further inland, on Sheet XCVIII, M. Caillemer reports the existence of an unusual type of *limitatio* in the midst of the 200 *jugera* units (710 m. square). This consists of a group of six parallel *limites* placed about 400 m. apart. The new picture of centuriation in Tunisia is full of features that are still puzzling. A pressing problem is the uncertain relation of this system in the Djebeniana area to the distant areas of centuriation to west and south-west, which we can only briefly notice here.

#### *Western Tunisia*

Another area of *limitatio* which has recently been studied from the air photographs, with interesting results, is that which lies a long distance inland, near the Tunisian-Algerian frontier, in the mountain valleys round Haïdra (*Col. Ammaedara*). This system and its orientation played an important part in Barthel's argument for a province-wide lay-out of *limitatio* across *Africa Nova* from the time of Augustus. Indeed he calculated that the crossing of the master lines of the *Cardo* and *Decumanus Maximus* lay between Haïdra and Djebel Bou Hanech. He arrived at this conclusion by numbering backwards from inscribed boundary stones in south Tunisia to this supposed point of origin in far distant western Tunisia.

The actual remains of centuriation have now been definitely located for the first time in this crucial area between Haïdra and Djebel Bou Hanech, as the result of the study of air photographs at the Institut Géographique National. It is not surprising that these traces have proved elusive on the ground, for they are very fragmentary and exist chiefly in the form of a 'buried landscape',—with grass and weed marks outlining the buried lines of the roads. Thanks to the assistance of M. Caillemer, I have been able to study these photographs also: they show that in this area centuriation went completely out of use and became a 'dead' landscape as in Apulia. The small patches of modern cultivation and the irregular local trackways in this wild and desolate region pay no attention to the earlier lay-out,—and erosion has bodily removed many traces of it.



There is a further matter of still greater interest. In this vital area,—so M. Caillemer points out,—the *cardines* are in fact inclined at an angle of *c.* 28 grades (25 degrees) from the east,<sup>1</sup> and not at 42 grades (37-38 degrees) as is required by the system according to Barthel,—who linked it with that in the south. The report of such a discrepancy is puzzling: full investigation on the ground is needed.

### *Southern Tunisia*

Many parts of this vast region were acrially surveyed during and since the last war, but it has not yet been possible to consolidate all the new evidence. Such bare terrain is well suited to revealing an abundance of traces from the air,—and one zone to be mentioned particularly lies about 30 miles north of Gafsa.

The reconstruction<sup>2</sup> of *limitatio* from the numerous inscribed boundary stones (*termini*) in the south is justly famous and needs no summary here. The *limites* penetrated even the remote fastnesses surrounding the Schott el Fedjadj. The work of centuriation on these distant and hostile frontiers could not have been a smooth, short or un-military operation. Beginnings were perhaps made under Augustus, with a skeleton of essential roads as a start. In 30 A.D., Legio III Augusta was hard at work on the surveying, and *limitatio* was still continuing under Trajan. Although so much of the region appears useless desert today, it will not surprise students of ancient history that extensive plantations of tree pits (no doubt for olives) have been located from the air,—bearing witness to the fruits of a rigorous policy of water conservation which we have considered above.

\* \* \* \* \*

Two conclusions follow from the new evidence which has rapidly accumulated. Naturally, accuracy is the heart of the matter. The first practical requirement is the close dating of the various systems of centuriation, to replace the conjectures which have been repeated for a generation. Only *excavation* can provide this, but there is now a super-abundance of sites from which to choose. The evidence is in the soil: the historical conclusions are waiting to follow from it, if given the opportunity. The innumerable sites of farms and local settlements along the *limites* provide the test conditions,—as we have proved in Apulia. They could confirm the hypothesis of an Augustan origin for the massive piece of planning between Sousse and Chebba. What, then, is the period of the earliest farms along the *centuriae* in the contrasted system round Djebeniana? Was the centuriation of Cape Bon completed by the days of the Gracchi?<sup>3</sup> Even without

<sup>1</sup> He also reports that there is a discrepancy between Roman boundary stones in this area and the visible alignment of the centuriation on the photos.

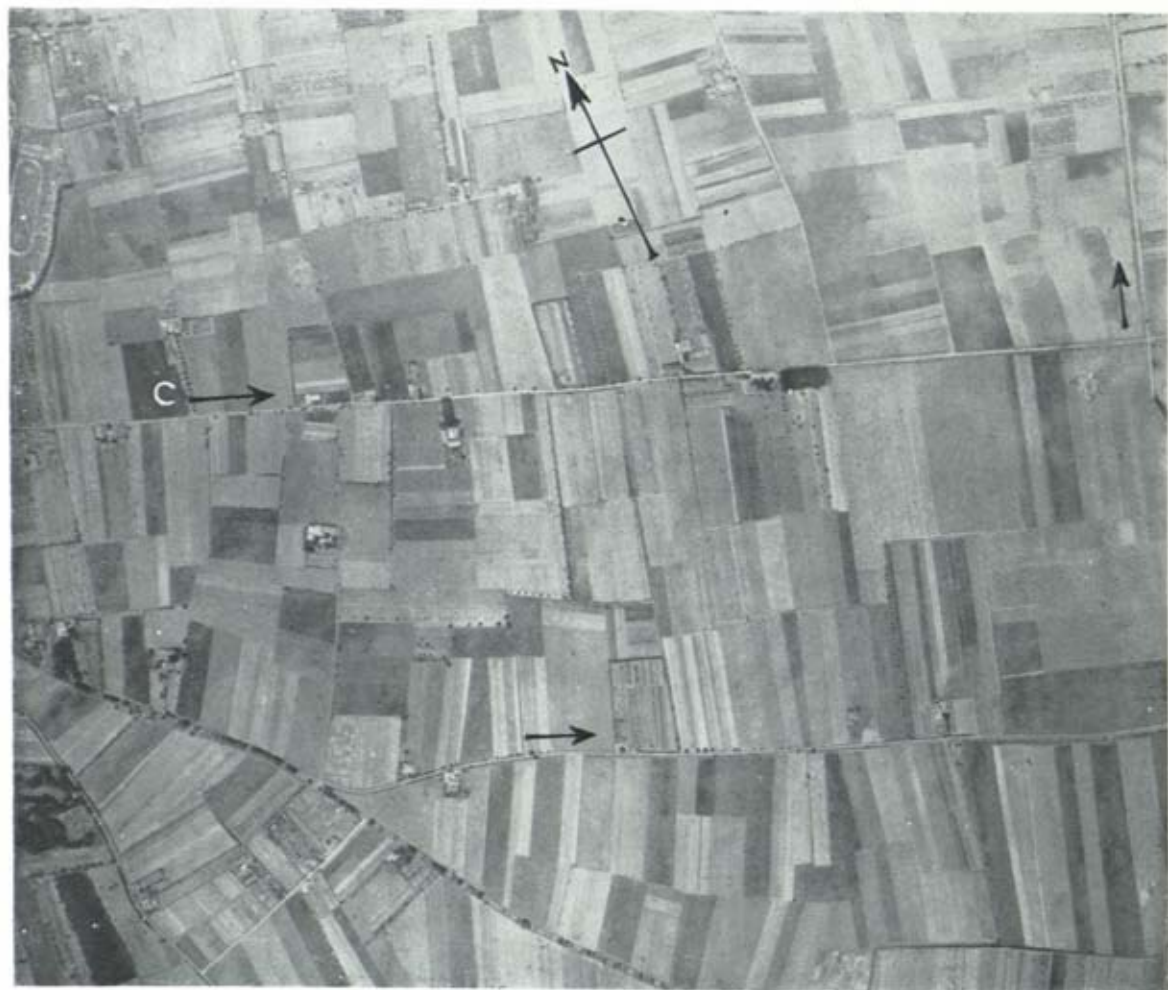
<sup>2</sup> Cp. Toutain in *Mémoires présentés à l'Acad. des Inscr. et Belles-Lettres*, XII, pt. 1, 1907; and Barthel, *op. cit.*, taf. I and taf. VI, 1911.

<sup>3</sup> One of the merits of a centuriated plan is that it is well adapted for extension on the same axis at a later date.





50. SOUTH FRANCE, VALENCE. Traces of the square units of the Roman street-plan have survived. The road marked 'C', from Valence to Chabeuil, corresponds to one of the *limites* in the system of Roman centuriation found from the air (Fig. 20), and was perhaps its *Decumanus Maximus*. The present curve of the Rhône can be seen at the left. See p. 207. Vertical photo. *Crown Copyright Reserved.*



51. VALENCE, vertical photo of an area south-east of the town, showing three straight roads corresponding to the alignment of the Roman centuriation which was based on squares of  $20 \times 20$  *actus* ( $776 \times 776$  yards). Road 'C' is the continuation of that marked on Plate 50, from Valence to Chabeuil.  
See p. 209. *Crown Copyright Reserved.*





52. SOUTH ITALY, PAESTUM: the site of the famous Greek and Roman city. The plan of its buried streets was discovered from a study of R.A.F. vertical photos taken in 1943-5. Parallel light-toned lines, produced by soil- and crop-marks on the surface, show the exact alignments (approx. north-south). Ground-checks by the author in 1949 and 1953, and recent Italian excavations, confirmed the accuracy of the original identification. The oblong area enclosed by the city walls is outlined by a modern road. See Fig. 21 and p. 218. *Crown Copyright Reserved.*



53. PAESTUM (a) *above*. The excavated portion of street 'C' (Fig. 21), confirming its buried alignment previously observed from the air. (b) *below*. Blocks of stone protruding through the grass, on the line of the un-excavated continuation of street 'C'. Such remains contributed to form the soil-marks which helped to show the buried street-plan. See p. 224. *Phs. Bradford*, 1953.



excavation, selective fieldwork alone could do much, for surface finds (especially of coins) are not to be despised. The second requirement is a further examination of Barthel's thesis of a single uniform system of planning outside the borders of the original system in the north-east.

### FRANCE: VALENCE AND ORANGE

I shall take my illustrations from one other Roman province,—Gaul. Until

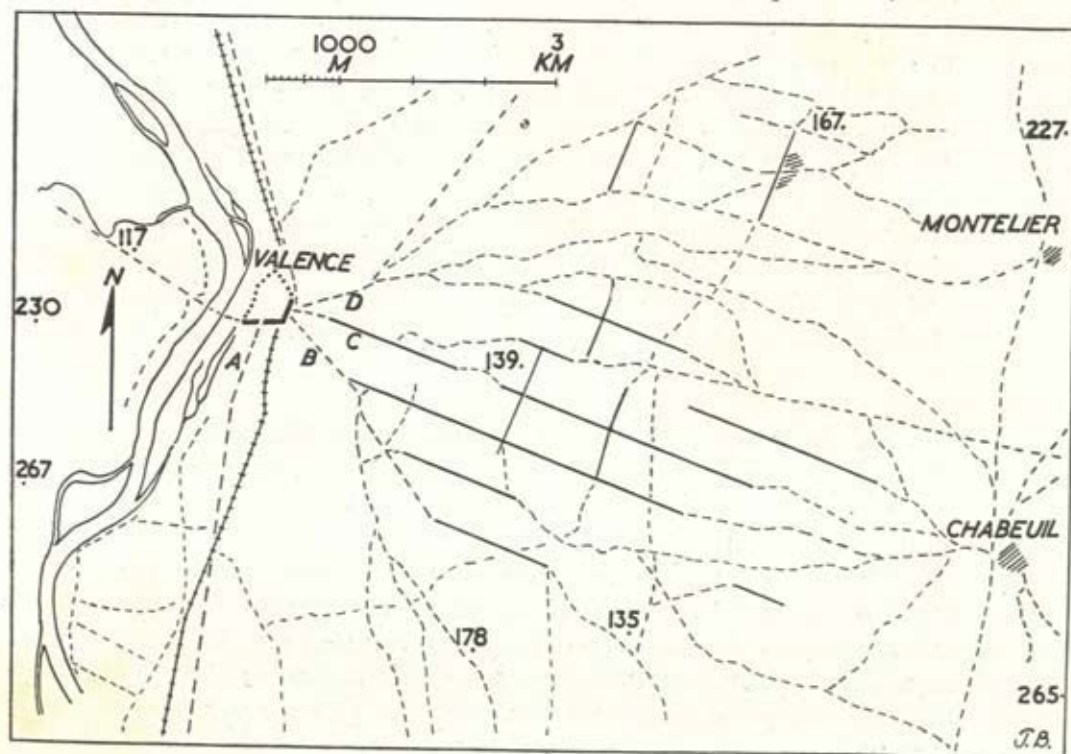


FIG. 20 Valence, Rhône Valley. Traces of a system of Roman centuriation, based on units of  $20 \times 20$  *actus*, discovered and mapped from air photos. Existing roads and field boundaries preserving the lines of *limites* ———. Other roads - - - - . Spot-heights in metres. See Plates 50-1 and pp. 207-10.

lately it could not provide tangible evidence, on the ground, of a single system of centuriation to compare with those across the Alps. Professor Grenier has written 'il est étrange que sur le territoire français nous ne puissions citer d'exemple analogue. . . . Il reste à en relever les traces'.<sup>1</sup> The situation has long been anomalous.

Soon after the War, however, while searching for traces of centuriation in Gaul, I observed clear and well-preserved remains of a system at Valence in the

<sup>1</sup> *Manuel d'Archéologie*, Vol. VI, pt. i, p. 19; cp. also Vol. V, p. 94.

Rhône valley. Fig. 20 shows its plan, as provided by the air photographs which originally led me to its discovery.<sup>1</sup> This was reported at the time of the exhibition of archaeological air photographs at the Ashmolean Museum in 1948.

Valence, *Colonia Valentia*, is a puzzling foundation; perhaps by Julius Caesar or the Triumvirs,—one among the group of *coloniae* established in this region after Caesar's Gallic campaigns. The centuriation of the surrounding land should also date from this time; but no mention of it is preserved in historical sources.

Since then the town has kept a certain modest prosperity. Its importance as a nodal point on a major route has stayed with it to the present day. It was a bishopric from late Roman times, and from the 16th to 18th centuries had a university in which Rabelais and Scaliger worked. In short it is one of those moderate-sized provincial cities, with 2000 years of urban life behind them, which contributed so much to the civilisation of southern Europe. But such continuity was only a contributory cause of the preservation of *limitatio* outside the town; more influential still was the fact that the west to east Roman roads (*decumani*) had a practical use for the later inhabitants of the district, in linking Valence and Chabeuil. For this reason these *decumani* were not superseded by the usual radial trackways from medieval towns. It is interesting to see how clearly this significant fact can be demonstrated, for the surviving fragments of the parallel *decumani* are visibly 'magnetised' inwards as soon as they come within range of these opposite 'poles', Valence and Chabeuil. In the area between these communities the layout of Roman centuriated road-system happened to fulfil a local need in the later landscape. But the *cardines*, from north to south, did not contribute to these simpler needs, and they have virtually disappeared. There are some possible, but doubtful, traces farther north.

The remains of the system at *Valentia* are of special interest,—far greater than their slight traces alone might suggest. For these remains give us an example of the way in which a Roman gridded system was able, or unable, to 'work its passage' through the more spontaneous landscapes of later periods,—either to reach the present day or to disappear in the process.

The town is slightly raised above the river, standing on the edge of an old river terrace. Its street-plan (Plate 50) still contains elements of its regular Roman layout, though certainly bent and battered when compared with the symmetrical blocks of Verona (Plate 62) or Piacenza (Plate 63). But big, rectilinear blocks<sup>2</sup> are clear in the north-east quarter of the town. The main road up the Rhône Valley can be seen (Fig. 20, A) approaching the town; the south

<sup>1</sup> M. André Blanc has published a good air photograph, showing some of the *limites*, in *Cahiers Valentinois* I; *Valence Romaine*, 1953, p. 19; a booklet printed for the International Institute of Ligurian Studies, Bicknell Museum, Bordighera. See also *Revue d'Etudes Ligures*, 1953, 35-42. *Corpus Inscr. Lat.*, XII, No. 1748 gives an interesting inscription (now lost) dedicated by the colonists and inhabitants to a named *patronus*, a high official who was capable of defending their interests.

<sup>2</sup> Blanc, in his useful booklet (*op. cit.*, fig. 38), gives a probable reconstruction of the Roman street-plan, with a division into rectangular *insulae* having their longer axis from north to south. There is a good specimen on the east edge of the enceinte.



gate is known from excavation. This road bisected the street-plan, as its *Cardo Maximus*, and left by the north gate (now destroyed). Apparently this gate lay near the apex of the big triangular zone of barracks, and these cover an area which was included in the ancient enceinte. In the north-west corner of the old town the position of the Roman theatre is preserved by a semi-circle of houses. The site of the forum is unknown.

A broad boulevard outlines the former circuit of the Medieval and Roman walls. The original river frontage of the town followed the edge of an old river terrace; this terrace is still well marked by a slope and by a continuous line of buildings including the cathedral. A side-channel of the river (cp. Fig. 20) must have flowed along this line, with an island between it and the main stream; it has been largely filled-in but marshy traces still remain.<sup>1</sup> The course of this and of other old meander channels above and below the town, which are now defunct, have to be considered collectively, and can be studied particularly well on high-altitude vertical photographs which show the valley as a whole.

The geomorphology of the position is thus as follows:—the Rhône is, or was, clearly a river with braided courses at Valence; the frontage of the Roman site followed the edge of the lower river-terrace, and its fields stretched across the wide, higher terrace outside the town to the east.

Radiating from the point at which the eastern gate probably stood three roads strike through the modern suburbs, heading east (as also at Vienne further up the valley). One (B) to the south-east has its origins in a recorded Roman road, discussed by Grenier and by Blanc. It led ultimately to the Mont Genève pass, crossing the Cottian Alps and coming down to Turin. The road to the north-east (D) is on an ancient route through the town of Romans and up the Isère valley to Grenoble (*Gratianopolis*), thence across the Graian Alps into Italy via Aosta.

It is the middle road (C) of these three, today leading to the village of Chabeuil, that deserves special attention. For this was, with every probability, the *Decumanus Maximus* of the centuriated landscape outside *Valentia*. It sets out boldly from the *colonia*, exactly in the manner of the model system pictured in the Roman surveyors' manuals, and recalls especially that vignette<sup>2</sup> of the Roman colony of Spello with its *ager centuriatus* which illustrates the writings of Hyginus. At Valence the *Decumanus Maximus* is set at right-angles to the north-south axis of the town-plan and, although its line is slightly bow-shaped<sup>3</sup> at first, it maintains a generally straight course for a considerable distance. In

<sup>1</sup> A stream still flows on this line through the Parc Jouvet (Plate 50 bottom right). The broad flights of steps from the Champ de Mars down to the Parc Jouvet mark the edge of the river terrace.

<sup>2</sup> For Castagnoli's comment on this drawing, see *Atti della Reale Accademia d'Italia*, serie VII, vol. IV, fasc. 4, 1943, p. 106 and fig. 5.

<sup>3</sup> The deviation seems to be caused by attraction towards the central 'Place', containing the modern municipal buildings. The straight alignment, from outside the suburbs, would, if prolonged, coincide with the next east-west street further north. This is the street which Blanc restores as the possible *Decumanus Maximus* of the city, bisecting its plan and corresponding to the line of a Roman main-drain.



all, six parallel *decumani* can be identified with certainty from existing minor country roads. On this stretch of level plain, terminated eastwards by hills round Chabeuil, the majority of the fields have retained their longer axis running from north to south as in centuriation in Lombardy. The field-pattern has been kept stabilised by the *decumani*. Its relative regularity sharply distinguishes this part of the plain from the countryside further up and down the valley, which presents a patch-work of small plots lacking regular orientation and threaded by a complex of winding streams. On the narrow strip of level ground on the opposite bank of the Rhône no definite traces of centuriation can be seen.

The average width of the units of centurial division is equal to 20 *actus* (c. 776 yards, 710 m.),—no doubt part of normal squares of 200 *jugera*. M. Blanc is of the same opinion. There is space for about 100 *centuriae* in the area divided by the *limites*, if we restore the system as a completed rectangle between Valence and Chabeuil. But, clearly, these are only the vestiges of a large system needed for a *colonia*, of which the rest has perished.

In general, centuriated systems which would have used ditches for the divisions and boundaries (as at Valence) are less likely to survive above ground than are similar *limites* in terrain where stone walls are the natural form of boundary (e.g. Istria, Dalmatia, Tunisia),—unless continuity was very strong as in parts of Italy.

The very limited survival of centuriation at Valence carries important lessons when we search for its remains round other Roman *coloniae* in Provence. Here I shall mention only one,—Orange (*Arausio*). Several generations of historians have debated the interpretation of the famous inscriptions, fragments of a land-register, which have been found little by little within the site of the Roman and modern city. Professor I. A. Richmond and Mr. C. E. Stevens clarified the problem in an important paper in the *Journal of Roman Studies*, 1942, 65-77, and analysed two distinct elements, (i) those which referred to units of land (called *merides*) inside the city, (ii) those which listed agricultural land outside it, measured in *jugera* in centurial units. I need not review the details of these well-known discussions, to which the recent discoveries of further fragments of the inscriptions have added.<sup>1</sup> But definite traces of centuriation round the *colonia* had not been confirmed from the study of the existing maps. Here was a case eminently suitable for a study of vertical air photos, which *per se* should show additional details; and during the last ten years I have many times examined suitable air photographs of Orange and its environs in the hope of confirming traces of centuriation.

On a first inspection of the terrain from the air, it appeared doubtful if

<sup>1</sup> The evidence from the fragments of inscriptions found during the last few years was discussed by Prof. A. Piganiol, *C.R. Acad. des Inscr. et B. Lettres*, 1954, 302-10. He describes a 'nid de marbres' recovered by M. Sautel; only three of the fragments are connected with the 'cadastre rural', the rest are concerned with land in the city. 'Une inscription monumentale qui couronnait apparemment l'un de ces cadastres fait savoir que l'initiative du travail est due à l'empereur Vespasien'. *Cp. Gallia*, 1955, 5-39.



positive evidence of rural *limitatio* still existed. But later experience, gathered from a search for such remains all over Europe, inclines me to the belief that faint traces are, in fact, visible. It must be made clear that they are far less distinct than those at Valence. West, east, north and south of Orange there are a few minor roads and field-boundaries which are relatively straight, and seem to preserve possible traces of an ancient regular division, orientated north-south and east-west. But the degree of their survival is so poor that it is difficult to calculate the size of the original units.<sup>1</sup> Such evidence gives cause for no more than 'modified rapture'. But on a future occasion I hope to describe the details because they will demonstrate how completely a system of *limitatio* could disintegrate. The circumstances are of a completely opposite kind to those at Zara and Salona. At Orange, if it were not for the epigraphic evidence of rural centuriation, I doubt if the topographic remains would arouse any interest. Aerial survey has indicated similar fragmentary traces along the Via Domitia (e.g. at Narbonne and Béziers) but only two small-scale air photos have yet been published (by Max Guy, *Etudes Roussillonnaises*, 1954-5, 217-37).

#### CONCLUSION: VARIETIES OF LIMITATIO

In conclusion a word must be said on some other aspects of regular Roman land-division. In terms of field archaeology they have never received the comprehensive study that is deserved, and the end of a chapter is not the proper place to attempt one. Nevertheless a few points must be mentioned, to preserve the balance. There is no need to go over the ground of old debates, for the literary evidence has received much analysis.<sup>2</sup>

Vital facts are waiting to be contributed by the methods of field archaeology, and these final words are written from that point of view. It is doubtful whether all the problems to be mentioned can be graphically demonstrated or resolved by remains surviving today, but it is probable that,—granted a resolute search,—most of them will prove capable of elucidation, especially if 'total mapping' from the air is used. Now that the field study of centuriation on colonial lands is in train, its application to other branches of *limitatio* needs to be further developed.

Air survey and test excavation in Apulia have made good progress in producing the solid, three-dimensional facts that bring to life the bald entries in the *liber coloniarum*.<sup>3</sup> A new topographical approach could now be made to

<sup>1</sup> Measuring from the latest maps revised from air photos (U.S. Army Map Service, 1 : 25,000, 1952), the divisions appear to average approximately 700 metres. But a comparison with other recent maps has shown a small variation when we try to calculate this figure.

<sup>2</sup> Further works which deal with topics in this section include: Mommsen, 'Die interpolationen des gromatischen corpus', *Bonn. Jahrb.*, XCVII, 272; Schulten, 'Flurteilung und Territorien in den römischen Rheinlanden', *Bonn. Jahrb.*, CIII, 12; H. F. Pelham, 'The Imperial Domains and the Colonnate', *Essays on Roman History*, ch. XIII, 1911; Clausen, *The Roman Colonnate*, 1925; Abbott and Johnson, *Municipal Administration in the Roman Empire*, 1926; Tenney Frank on the Ager Publicus, *J.R.S.*, 1927, 141.

<sup>3</sup> See also *The Italic Regions*, by R. Thomsen, Copenhagen 1947. The entries in these lists contain valuable



locate other types of land-unit whose location in Italy is specifically listed. There were towns whose *ager* was divided in *lacineis* (usually translated as 'by strips'), viz:—Antium, Ardea, Formia, Interamna, Laurum Lavinia, Venafrum. A division in *lacineis et per strigas* is recorded for the land of Ostia and Atina, in *praecisuras et strigas* for Terebentum (Terventum), *per strigas et scamna* for Ecicylanus (Aequiculanus) and Reate. Methods of a more idiosyncratic nature are also mentioned, e.g. unusual parallelograms delimited between Portus and Rome. Within reason, the more unusual the method the greater the hope of distinguishing some trace of it today.

We read, for instance, of the *ager* of Beneventum<sup>1</sup>:— 'In Beneventano actus viginti quinque per decimanos, et actus sedecim per cardines; qua mensura iugera ducenta quidem includuntur, centuriae quadratae non exprimuntur'. Divisions of  $25 \times 16$  *actus* ought to be distinctive if anything remains, and a topographical study with maps and air photos was made by the present writer. It successfully identified traces of some of these unusual divisions, preserved in the inchoate mass of existing field-boundaries and minor roads.

In the case of Beneventum the measurements of the units were available to establish the correctness of the identification, but the *libri coloniarum* do not give such data for the size of *laciniae*, *strigae* or *scamna*. Dr. Castagnoli has drawn attention<sup>2</sup> to an area near Laurum Lavinia (the modern town of Pratica di Mare, south of Rome). This area is now divided by a group of minor roads which run parallel, and delimit rectangular strips which measure c.  $360 \times 220$  metres (approximately  $10 \times 6$  *actus*). He interprets these as very probably remains of the *laciniae* which are attributed to this town in the *libri regionum*. It would be welcome to have a definite example of this method of land-division under one's eyes,—but further proof is needed, particularly in a region which has received much agricultural systematisation in recent times.<sup>3</sup>

My detailed account of the systems of *limitatio* discovered in Apulia will give further particulars of the search in Italy for tangible traces of these little-known units of Roman land-use. Leaving this aspect then, we may glance briefly at the provinces. Here we again encounter those rectangles named *scamna* and *strigae*, termed as their longer axis lay east-west or north-south respectively. For over a century, discussion has been given to the occasional references by the *agrimensores* to these ancient forms of land division; little

---

details about centuriated systems in Central and South Italy.

In preliminary articles in *Antiquity* (e.g. 1949, pp. 66-7 and 69, n. 14) I showed that aerial discoveries of buried centuriated roads in Apulia had confirmed data (previously doubted by some commentators) which are contained in the *libri coloniarum*.

<sup>1</sup> Siculus Flaccus, *De cond. agr.*

<sup>2</sup> In *Bull. della Comm. Arch. Com. di Roma*, LXXII, 1946-8 (publ. 1951), commenting on an air photo in Lugli, *Saggi di Esplorazione Archeologica a mezzo di Fotografia Aerea*, 1939, pl. IV (in Tenuta la Crocetta, not S. Procula). Sheet 158/IV/N.W.

<sup>3</sup> This grid of rural roads was not shown on the Italian 1 : 50,000 map of 1878 revised in 1906, but it appears on the 1 : 25,000 sheet prepared from a survey in 1936.



advance has been possible. In the desultory search for the remains of strigation-scamnation in the field they have come to seem almost as intangible and elusive as the mythical creature in Lewis Carroll's *Hunting of the Snark*. Not that these units were remarkable in outward appearance. If it were not for a 'rarity value' their plain and practical outlines would hold no more mystery than an ordinary *centuria*. One of the chief reasons for the interest taken in them has been due to their reputed importance in the agriculture of the provinces,—according to the dictum of Frontinus: 'Ager per strigas et scamna divisus et adsignatus est more antiquo in hanc similitudinem qua in provinciis arva publica coluntur'. Another often quoted passage in Nipsus, another agrimensorial writer, specifically mentions 'agri scamnati in centuriis singulis' with measurements of  $20 \times 24$  *actus*. Such scamna were probably mentioned for their abnormally large size; we have noted that the term 'century' was sometimes used in a general sense to signify big quadrangular units, and not only those equal in area to 100 *heredia*. It is significant that no measurements of *scamna-strigae* are quoted in the *libri coloniarum*,—they were simply oblong units of a size variable according to need (the proportion of 2 : 3 for the sides was only a recommendation).<sup>1</sup> But essentially they were individual units, rather than subdivisions<sup>2</sup> of another. It does not seem probable that these units can be further elucidated by studying the texts alone,—for otherwise the commentators assuredly would have done so. The only approach is by field archaeology, and two courses are open at present. One is to make use of vertical air surveys in order to examine the environs of those towns in Italy which contained these units of division according to the *libri coloniarum*. By applying 'total mapping' some may be identified. Thus at Nursia and Reate the land was divided *per strigas et per scamna in centuriis*. Other areas to be examined include the environs of Aufidena, Bovianum, Istoniis (divided *per centurias et scamna*), of Alatrium (where centuriation and strigation were used), and Anagnia *per strigas*. For these places in Italy we have specific references to help us, but the traces may be hard to distinguish because the landscapes have been cultivated continuously. The alternative course is to attempt to locate scamnation or strigation in the provinces by its distinctive appearance. Schulten's alleged examples from Tunisia have now been rejected (p. 201), as the result of fuller mapping, but this modern mapping may produce genuine examples (cp. the oblong divisions found on Sheet XCVIII, p. 205).

In this chapter we have noted that division by *centuriae* was not applied only to the lands of military and veteran colonies; it can be seen round towns of the

<sup>1</sup> Barthel rejected Schulten's theory that an inscription from Cologne (*C.I.L.*, XIII, 8254; *possessores ex vico Lucretio scamno primo*) referred to the survey of the environs; *scamna* and *strigae* were used in the planning of camps, and the terminology was applicable to town-planning (*Bonner Jahrbücher*, CXX, 48). Further search might be made at Suessa Aurunca which was taken by Frontinus as a type-site of *scamna-strigae*.

<sup>2</sup> M. Weber's suggestion that they were to be equated with the ordinary subdivisions of *centuriae* was refuted by Schulten, *Bonn. Jahrb.*, CIII, 18, 22. If this suggestion were correct, every well-preserved system of centuriation would be full of *scamna-strigae*.



status of *oppida*, *fora* and *municipia* in Italy. If its presence at the provincial *municipium* of Tragurium (p. 190) was simply occasioned by the layout for the colony of Salona, it would nevertheless be easy to point to communities of several kinds of status which were associated with centuriated land in Tunisia:—imperial estates, private estates, the lands of miscellaneous cities, and even the settled tribesmen were all to be found within the grid. But *limitatio* was by no means conventional for the lands of most provincial cities, or so we are told. The town's territory would be defined as to its frontiers, but not divided by detailed boundaries: 'ager est mensura comprehensus cuius modus universus civitati est assignatus' (Frontinus). However, it is well known that centuriation was, on occasion, applied to *ager vectigalis*,—land rented on a revocable lease in return for vectigal. Apart from Tunisia, there is the often quoted reference in Hyginus to the case of land in Pannonia. The fact offended his professional instincts: 'mihi videtur huius soli mensura alia ratione agenda'. But Hyginus added: 'debet interesse inter immunem et vectigalem',—the crucial matter was not the century or its shape, but the tenurial status of the land. Obviously, topographical archaeology cannot distinguish the status of *centuriae* simply by their outlines.

The discovery of the *limitatio* in Pannonia remains one of the outstanding tasks. Perhaps this survey was carried out at the time of the census of A.D. 10,—that is, contemporary with the great extension of centuriation in Tunisia. It is improbable that many traces of *limitatio* in Pannonia have survived the Dark Ages in the form of roads or boundaries above ground. There should, however, be traces of buried landscapes as in Apulia,—with markings over the ditches demarcating the *centuriae*. But intensive strip-cultivation in recent times (cp. pp. 45, 78) must increase the difficulty of discovering such remains.

In 111 B.C. a law was passed which provided for the survey of the lands of the city of Corinth, which were confiscated and sold at that time. But a study of maps and air photos in 1945 could not confirm definite traces of *limitatio*. In Spain there are possibilities for mapping centuriation, of which I have written above (p. 76). In Cyprus, during a visit in September 1955, I studied an air survey (1949) of the island in search of any traces; and in passing I may mention the existence of numerous small rectangular fields, in use, on the plain west of the site of the Roman city of Salamis (p. ix). Parts of this field-pattern must be old, but on present evidence its layout seems too irregular and the divisions not sufficiently standardised, to establish the survival of centuriation. Elsewhere, Cyrenaica clearly offers a field for investigation. Here Rome took control of the estates of the Ptolemies, which became *ager publicus*. Can we identify today any definite traces of a *centuriatio*? For advice on this problem I am very grateful to Mr. Richard Goodchild, of the Department of Antiquities in the Kingdom of Libya, who has examined an air photograph mosaic (1 : 25,000 scale) which covered the entire zone of potential ancient settlement. In summary his conclusions are that, although there is a complex pattern of land-division on the upper plateau (not far from Cyrene) with straight field-boundaries, some of



which can be traced for several kilometres, these may in origin represent Ptolemaic work; and, in addition, such field-boundaries are not always parallel, and there is an irregularity in their lay-out which argues against a Roman origin,—at least if centuriation is defined in a strict sense. I have personally examined air photos which show remains of these straight boundaries, long abandoned but still very clear on the ground as stony, white, soil-marks. Their outlines are impressive in the aerial view. Perhaps Rome was content, primarily, with absorbing and using an existing field-pattern, but the extent of the remains requires much additional field work in order to establish the facts.

The vestigial nature of the traces of the systems which have been brought to light at Valence and Aquileia has usefully shown that we can legitimately give a certain indulgence to the slight indications of *limitatio* which alone survive in some provinces. In this country Mr. Margary has made a strong case for the existence of such remains at Ripe in Sussex.<sup>1</sup> There, country roads and local boundaries have undoubtedly perpetuated an old division into rectangles. When measured these contain 210 and 240 *jugera*; if, or when, confirmed by excavation they should represent a *limitatio* of public land by strigation-scannation in the manner said to be characteristic of the provinces. In origin it may prove to have been a land-settlement from the Roman station at Pevensey. In the same category should be classed the suspected remains of a Roman land-settlement which Mr. Nightingale has reported from Cliffe near Rochester, Kent.<sup>2</sup> We cannot expect to find well-preserved *limitatio* in Britain; such fragmentary boundaries as those noted at Ripe and Cliffe are the best that can be expected,—neither better nor worse than some definite survivals in the living landscape elsewhere. At Cliffe the boundaries are spaced in multiples of *actus* units; the area is surrounded by Roman remains and has a tradition of agrarian use from Saxon times,—in addition the alignments make sense in relation to the Roman roads. Once more, excavation is the only test. If the lines of these country lanes and local divisions were once *limites*, then proof of buried Roman roads bordered by ditches should be recoverable by digging, as in Apulia. As Haverfield observed in a trenchant article, it is hard to explain precisely why such boundaries may survive in some parts of England and not in others,—‘we can only note what has happened’.<sup>3</sup>

The test of excavation is even more obligatory in the case of the alleged traces of systems in Germany and Switzerland.<sup>4</sup> It must be left to the reader to form his

<sup>1</sup> *Sussex Arch. Collections*, LXXXI, 31-41; *Roman Ways in the Weald*, 204-7.

<sup>2</sup> M. Nightingale and C. E. Stevens in *Archaeologia Cantiana*, 1952, 150-9. For criticism of attempts to find *limitatio* at the *coloniae* of Lincoln and Colchester cp. I. A. Richmond, *Arch. Journ.*, CIII, 61, 66. Aerial study of the extensive remains of Roman fields in the Fenlands of eastern England has (so far) produced no evidence of true centuriation there. Traces in Middlesex alleged by Sharpe have long been dismissed as fanciful.

<sup>3</sup> *J.R.S.*, 1918, 289.

<sup>4</sup> Cp. Klinkenburg on alleged traces round Cologne, *Bonner Jahrbücher*, 1936, 259-98; Laur-Belart, ‘Röm. Landvermessung in dem Kantonen Baselland und Solothurn’ in *Tatarinoff Festschrift*, 1938, 41-60; Stohler, ‘Zur Limitation der Kolonie Augusta Raurica’ in *Zeitschr. für Schweiz. Arch. und Kunst.*, 1946, 65-79.

own judgment of these, but to the present writer the evidence is, at present, insufficient in its existing form. Proof is in the soil. Without satisfactory proof from excavations on the putative lines of the *limites* it is profitless to debate the scanty and nebulous hints suggested by a few scraps of modern roads which seem in loose agreement with intervals of Roman measurement. In a fertile area with natural limits there will usually be a tendency for the roads and boundaries to be fitted to it, and sometimes it seems that one could make a selection that would agree with intervals of several kinds. A critical attitude to attempted reconstructions must not be relaxed.

In all doubtful cases, tests by excavation should be the rule, not the exception, in contemporary archaeology.



## CHAPTER V

# THE CHANGING FACE OF EUROPE: CLASSICAL AND MEDIEVAL TOWN PLANS

*Paestum; Discoveries within the City 218, Cosa and its Harbour 227, Carthage: the Port 231, Ostia (i) the City 237, (ii) the Piana Bella and Ancient Coast 242, (iii) the Harbours of Claudius and Trajan 248, Verona and the River Adige in the Roman period 256, Roman Planning at Piacenza and Pavia 261, France; the Oppidum of Gergovia 263, Carcassonne 265, Italy: Medieval Planning at Castelfranco, Cittadella and the Site of Le Motte 266, The Fortress of Palmanova 270, Dalmatia; Ragusa 273, The Aegean; Delos 274, Rhodes; Discovery of the Classical Street-plan, 277.*

THIS CHAPTER does not pretend to examine and illustrate adequately the evolution of urban civilisation in Europe as displayed in its town plans. But some small clearings can be made in this forest of problems by means of the study of air photographs, although I can only hope here to prepare the way for a more comprehensive survey. A full use of such photograph-plans could, also, be a valuable adjunct in any revision of earlier works on this subject.

The study of ancient town-planning continues to make notable advances,<sup>1</sup> but there is still considerable scope for work and discovery in all periods, even in matters which have long been the subject of study. Thus, the recent discovery at Jericho of an extensive community living in well-built houses inside massive walls as long ago as the early Neolithic (pre-pottery) phase, before 7000 B.C., has forced us to re-cast some of our beliefs about the way in which urban civilisation first appeared. Many conclusions about much later developments, too, are likely to be revised by field archaeology in the coming years. For example, in 1956 I mapped from air photos the buried plan of Arpi (a city of pre-Roman origin) in South Italy, no less than 3 miles in diameter!

I have said that air photographs have a dual rôle in archaeology,—primarily to reveal discoveries, but also to demonstrate known facts in a new light. In dealing with town-plans in this chapter, the emphasis will fall on both of these aspects. There are still many discoveries to be made, even in connection with some of the most famous living towns or deserted city sites.

<sup>1</sup> See, for example, the series of articles on various periods appearing in the *Town Planning Review*, summarising recent work, e.g. Ward Perkins, 'Early Roman Towns in Italy', Oct. 1955.

To give unity to this chapter I have confined my attention to southern Europe and Mediterranean lands. For the latest work on town-plans of north-west Europe, see R. E. Dickinson, *The West European City*, 1951.

## PAESTUM: DISCOVERIES WITHIN THE CITY

As an example of such aerial discovery, let us first consider the results obtained at Paestum (Plate 52 and Fig. 21), on the Bay of Salerno, 50 miles south-east of Naples. It was in 1943 that the study of war-time vertical photographs covering the area of the ancient city first showed me the indications of its buried plan of parallel streets, framing regular 'blocks' or *insulae*, whose traces had not been previously mapped.<sup>1</sup>

Before passing to a consideration of the air photographic discoveries, there is need that we should first recall the beginnings of archaeological exploration at Paestum and briefly review the outlines of the city's history. For it is important to keep in mind that scientific excavation here is only a recent development and, consequently, a surprising number of major problems still wait to be solved.

To understand this position, it will help if we go back only 70 years to see the site as it was when described by that acute field-archaeologist Lenormant.<sup>2</sup> In those days the setting was wild and remote to a degree which is now difficult to imagine.<sup>3</sup> Viewed from a vantage point in the mountains behind, the great oak forest of Persano still lay in a dark green mass across one-third of the crescent of the coastal plain, near whose southern extremity the columns of the Greek temples rose above dense thickets of moorland scrub. A century ago it was still a real expedition to go from Salerno to Paestum, and few visitors risked it; for as late as the 1860's the Forest of Persano was the lair of Manzi and his followers, renowned brigands. Fever-stricken coastal swamps discouraged curious travellers still more effectively. Lenormant found that even in mid-September Paestum was deserted, from the fear of *mal'aria*. Those few who had not sought the hills were shaken with fever; 'tout le reste avait déguerpi, pour ne revenir qu'en octobre'. All this helps to account for the extraordinary fact that it was not until as late as 1734-40 that the 'discovery' of the Greek temples was announced by Count Gazola, an official of the Bourbon court. In the early Middle Ages the site was robbed for building material by Amalfi and Salerno. But it seems that thereafter the three temples were lost in obscurity, even during the Renaissance and the seventeenth century. It is a remarkable, but by no means unique, instance of archaeological myopia in that inquiring age. Perhaps it was a fortunate and protective obscurity. In 1943 the plain re-appeared in the main stream of history, as on past occasions. Fundamental features of the landscape reasserted themselves in the opposition of the plain and central beaches to a hostile mountain background. Ancient vantage-points like Capaccio

<sup>1</sup> My first report of this discovery at Paestum was given briefly in the *Guide to an Exhibition of Air Photographs of Archaeological Sites*, 1948, p. 16, published by the Ashmolean Museum, Oxford.

<sup>2</sup> François Lenormant, *A travers l'Apulie et la Lucanie*, 1883, Vol. II, pp. 164-224.

<sup>3</sup> Schemes for land-drainage and cultivation began to take effect at the end of the 19th century. A large part of the area north of the Sele river is now under vines and olives, giving no opportunity for air photographic discovery; but there are great possibilities south of the river where the plain is now covered by a sea of waving corn.



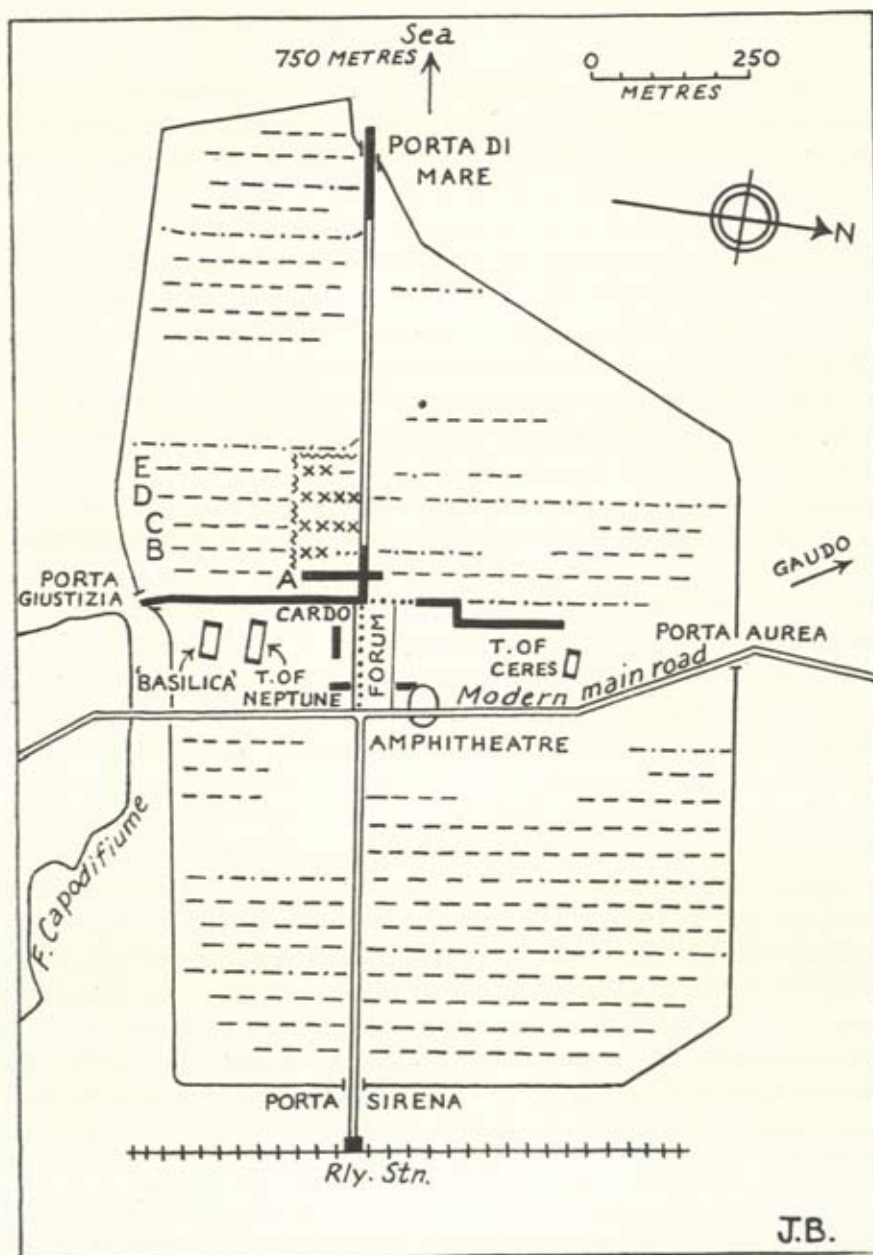


FIG. 21 Paestum (S. Italy). Indications of buried streets discovered from the air.  
 From soil-marks and crop-marks - - - - -  
 From existing field-boundaries, walls, etc. .....  
 Streets excavated at time of photography (1945) —————  
 Streets in area west of Cardo excavated since 1945 x x x x x

See Plate 52 and p. 218.

once more fulfilled their rôle. But by great good fortune Paestum emerged unscathed.

A matter of c. 3700 years ago, the boats of new arrivals had made landfall on the same beaches. Their cemetery at Gaudio (about a mile north of Paestum) which was found in 1943, during the construction of an Allied aerodrome, contained pottery that finds analogies in Sicily and the Eastern Mediterranean. After careful search I have not yet seen any indications of their settlement on air photographs (of August 1943 and February 1945). It might perhaps have been a village enclosed by ditches in the manner of those on the Foggia Plain across the Apennines, which I described in Chapter II. But it is quite possible that this prehistoric settlement was on the same site as Paestum, and has been totally covered by the buildings of the later city. Lenormant made a similar suggestion 70 years ago after finding polished stone axes there, which he later gave to the Musée de Saint-Germain.

Subsequent study and excavation have thrown light on the Greek colony of *Poseidonia* planted here<sup>1</sup> by Sybaris in the 7th century B.C. Strabo recorded the tradition that the site was already inhabited and that its occupants fled to the mountains. The famous temples were built successively between the middle of the 6th and the middle of the 5th century B.C. Their outlines are clear on Plate 52, as is the course of the city wall and ditch whose perimeter is followed by a modern road. On the ground, it is clear that the curious shape of this enclosure was due to the desire to site the defences so as to follow the edge of a flat bed of limestone rock which, in the western half of the city, rises slightly above the softer ground outside. The wall, 4,750 metres in circuit, is strengthened with towers, and at different periods has been much reinforced and repaired; a full description is not possible here. Its date is a difficult question. The wall as we see it might well be Roman (273 B.C. or later) but the first period may be Lucanian if not Greek.<sup>2</sup> Further study and excavation are needed. It is enough to call attention to the clear overall picture of the site given by this photograph-plan, a 'mosaic' assembled from photographs taken on 27 February, 1945. The only satisfactory plan from other sources is the small one inside the useful official guide<sup>3</sup> to Paestum (*Itinerari dei Musei e Monumenti*, latest edition 1953) by

<sup>1</sup> The circumstances of the foundation, its date in the 7th century, and its relationship to a possibly earlier Greek settlement at the site of the Heraion near the mouth of the Sele river, have been the subject of important review in the last few years; see T. J. Dunbabin, *The Western Greeks*, 1948, pp. 25-6. The conclusions of P. C. Sestieri (*Archeologia Classica*, II, 180 ff.; IV, 77 ff.) and of A. Maiuri (*La Parola dell' Passato*, XIX, 1951, 274 ff.) and in *Saggi di varia antichità*, 1954, 79-96, may be compared with this.

<sup>2</sup> See Sjöflund, *Acta Instituti Romani Regni Sueciae* 4 (*Opuscula Archaeologica*, i, 1935), 87 seq.

On matters concerning the town-plan I received much helpful advice from Prof. Axel Boëthius, Mr. T. J. Dunbabin, and Prof. P. C. Sestieri.

<sup>3</sup> But the topographical details of the map printed on the cover (copied from the Italian survey of 1908) need corrections, e.g. to the course of the main road north through the site, the river bend outside the south gate, etc. These are correctly shown on the plan inside.

There have been some changes, too, since the air photograph on my Plate 52 was taken. A large area round the 'Temple of Poseidon' (Neptune), and between it and the Forum, has now been excavated, and a fine new museum built beside the main road.



Professor Sestieri, its present excavator. The centre of the city (the Forum, and neighbouring streets) was dug by Professor Maiuri early in the 1930's, but plans were never published. Air photography was experimentally used during the excavation<sup>1</sup> of the Sanctuary of the Argive Hera on the Sele River, to the north.

Excavation in recent years has greatly enlarged our knowledge of the Roman period of the city's history. About 400 B.C. Poseidonia yielded to the attacks of the Lucanian hill-tribes from inland, and, after an obscure period in their hands, finally came under Roman rule in 273 when it was strengthened by a Latin colony, receiving the name of Paestum. The city enjoyed a good measure of prosperity under the Roman Empire, when much building was done. The Forum was probably constructed on the site of the Greek Agora. But by the 1st century A.D. we find complaints about the unhealthiness of the site, because the little river just outside the south wall was expanding into a malarial marsh. The same phenomenon in time reduced the surroundings of other cities in this part of Magna Graecia to the same condition, perhaps due to the cumulative effect of excessive felling and deforestation on the mountains inland that caused a much greater run-off of soil, which was washed down and choked the streams. During the Dark Ages, a shrunken community maintained itself round the Temple of Ceres which had been transformed into a church. Following Arab raids on the coast, the survivors retreated in the 9th century high up the mountain-scarp inland, to Capaccio Vecchio. This in 1245 was besieged by the Emperor Frederick II in person, taken, burnt and abandoned (thus becoming a deserted medieval village site of archaeological importance, as we confirmed in 1953 by field-work on these little-known ruins).

The plan of the city of Paestum, as visible to-day, has as its basis two chief streets, parts of which have been excavated to the level of the polygonal slabs with which they were surfaced in the Roman period. The two streets cross at right-angles near the centre and I shall follow the custom of naming the north-to-south axial street the '*Cardo*' and the east-to-west one the '*Decumanus*'. Reference to the plan in Sestieri's booklet will show how the direct line of the *Cardo* just north of the main crossing was complicated by Roman buildings on the west side of the Forum. It has been generally believed that both *Cardo* and *Decumanus* follow the lines laid by earlier streets of the pre-Roman city. Sestieri, for example, has stated that the *temenos* wall uncovered along the east side of the *Cardo* is that which enclosed the temple precincts in Greek times.

Before continuing on this point I should like to refer to an interesting fact which has been clearly shown on all the vertical air photographs taken in 1943-45 and 1954. They prove that the axis of the Greek temples is slightly different from that of the *Cardo-Decumanus* and the lines of buried streets. It

---

The names of the temples are a legacy from early antiquarianism. Sestieri gives newly excavated evidence for their probable dedications.

<sup>1</sup> P. Zancani Montuoro and P. Zanotti Bianco, *Heraion alla Foce del Sele* (Relazione preliminare) 1938, fig. 4; and in the Final Report, 1951, vol. i, tav. 2.



can plainly be seen that the west fronts of the temples are askew with the line of the *Cardo* and are not exactly parallel with its road-surface. There is no possibility of optical distortion in this case. The comprehensive view given by the vertical photographs also enables us to see that the three temples are all parallel with one another in their longer axis: on this point the position of the temple of Ceres on the plan in the official booklet needs correction. In order to explain this difference it might be suggested that the orientation of the temples was specially adjusted to meet the requirements of ritual,—conceivably in relation to some such matter as the position of the sunrise on a certain day, or festival.<sup>1</sup> Alternatively we may care to consider the hypothesis that the temples' orientation was fitted to that of the Greek town in which they were built and which seems to have been largely submerged under the parallel streets which have now been found. If this suggestion is proved correct by excavation, as it could be, then the temples would represent the rigid legacy of the older town, incorporated in an early Roman (or possibly Lucanian?) street grid.

The problem which air archaeology has put before us is a dual one, (i) the period when the parallel buried streets had their origin, (ii) the age of the *Cardo-Decumanus* axes.<sup>2</sup> A limited amount of further excavation should be able to give the solution. Thus, it would not be difficult to take up a length of the *Cardo* to find out what lies beneath, and to settle the claim that it perpetuates the line of a *ἱερά ὁδός*, a sacred way, of Greek origin. *A fortiori*, the same policy applies to the extensive plan of the lesser streets.

But we have much more than new problems,—we have new facts. Let us see what discovery has brought.

It was on the evidence of the photographs alone that I first formed the opinion that considerable traces of additional streets had been revealed by vegetation- and soil-markings that indicated their position and direction. Some years passed, during which the study of the air photographs was renewed from time to time, comparing those taken during the summer of 1943 and the spring of 1945.<sup>3</sup>

In August 1949 I visited Paestum to make a preliminary ground-examination of these traces of the street-plan, when en route for our first season of excavation in Apulia, and during September 1953 some days were spent in further field-work. On this latter occasion we were glad to find that proof was forthcoming of the air photographic interpretation, from areas in which Professor Sestieri had in the meantime opened trial excavations. It became possible, therefore, to

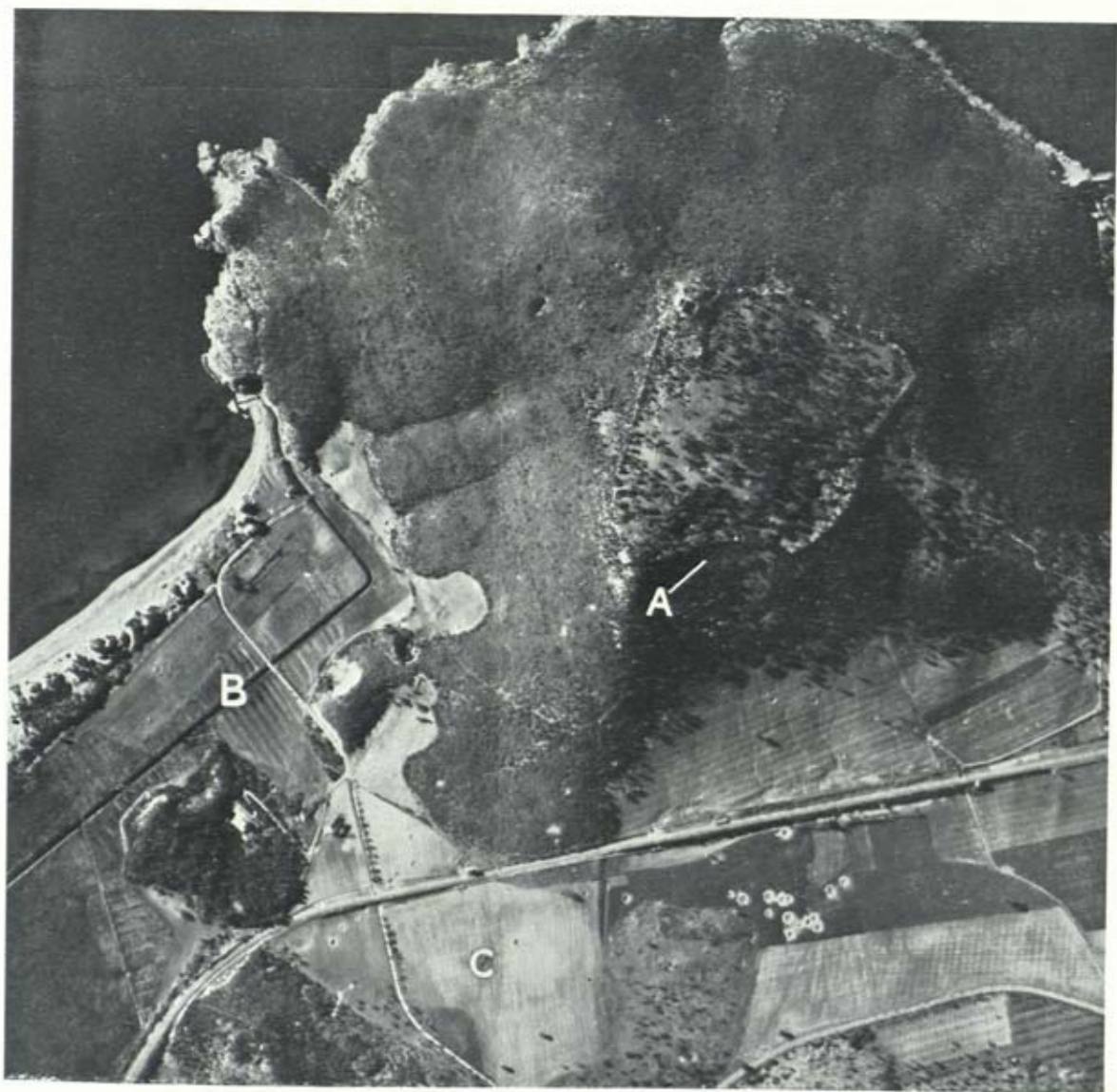
<sup>1</sup> For this matter, in relation to Greek temples in general, see W. B. Dinsmoor, *The Architecture of Ancient Greece*, 1950 ed., p. 49.

<sup>2</sup> I am specially indebted to Professor Boëthius for advice on this problem.

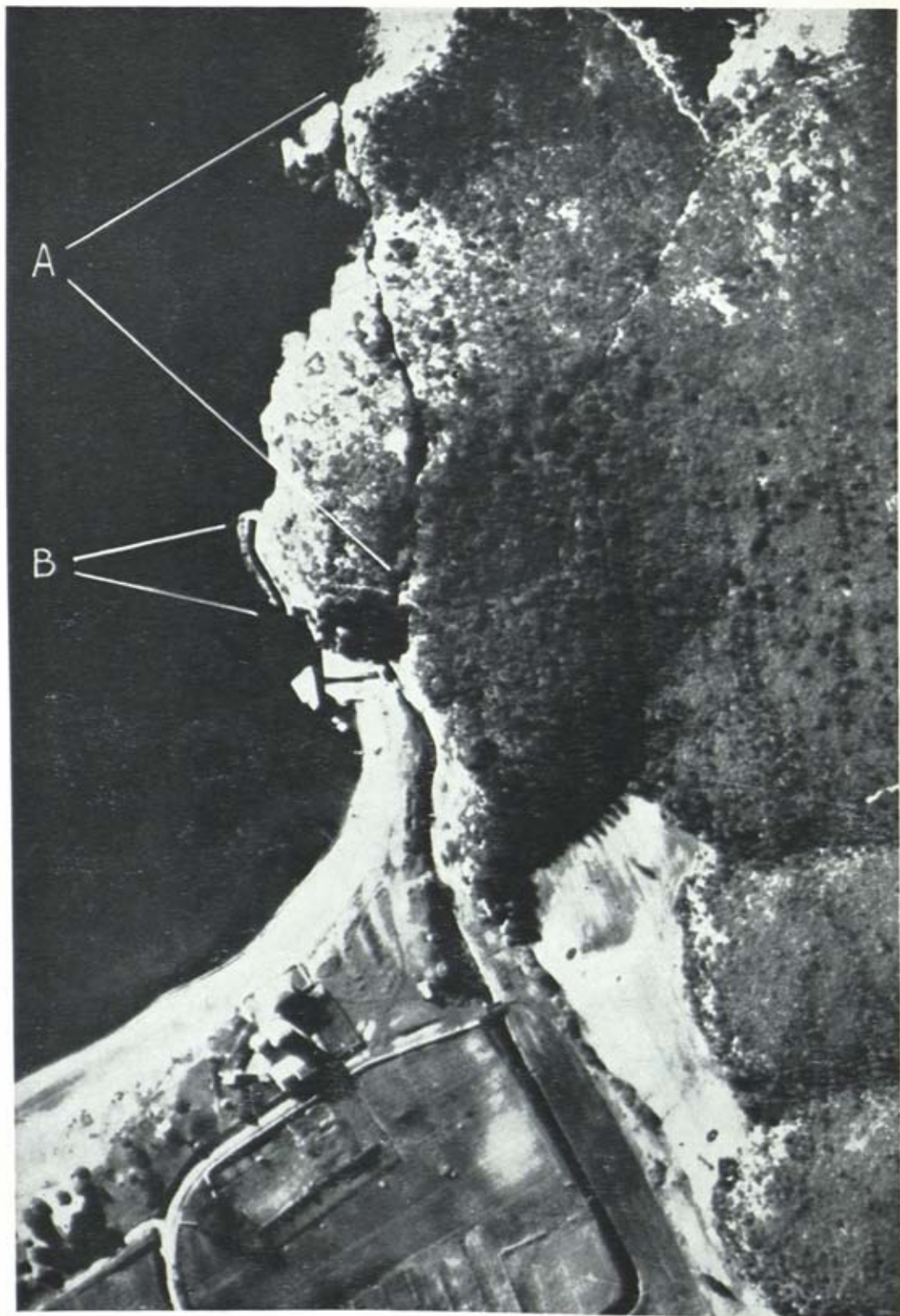
<sup>3</sup> The traces of the buried streets were visible as light-toned lines on the photos taken both in 1943 and 1945, and those mapped on Fig. 21 have been collated from the two series.

They can be seen also on an Italian vertical air photo taken in 1954, which was occasioned by my report of these discoveries. It is very well reproduced in the booklet entitled *Prospezioni Archeologiche*, tav. xii-xiii, published by the Fondazione Ing. C. M. Lerici, Politecnico di Milano, 1954.





54. COSA, 85 miles north-west of Rome. (A) The walled Roman hill-top town founded 273 B.C. (B) The site of its buried port. (C) The site of the later market town, *Succosa*. See p. 227 and Fig. 22. Vertical photo. Crown Copyright Reserved.



55. Cosa. Vertical photo, showing the Roman rock-cut channels constructed to keep the harbour free of silt: (A) Spacco della Regina, (B) Tagliata. See p. 230 and Fig. 22. *Crown Copyright Reserved.*





56. CARTHAGE. Vertical photos of the coast-line of the Punic and Roman city. (i) The lagoons are the last vestiges of the rectangular and circular Punic ports, well-known from descriptions in Appian, etc. Also, clear traces are visible of massive remains of rectilinear outline in the water in front of the promontory north of the Bay of Kram. The precinct of Tanit occupied the area marked by a white circle. (ii) (*inset*) The smaller quadrilateral in the sea, south of Bordj Djedid promontory; and the straight structural line off-shore, parallel with an axial line of the Roman street-plan. Scale of inset about 2/3. See p. 231. *Crown Copyright Reserved.*



57. The mouth of the TIBER. High-altitude vertical view (Scale *c.* 1 : 48,000), contrasting (A) the post-Roman accumulation of parallel lines of dunes, (B) the 'Piana Bella', and (C) the marshy zone inland, flooded when the photo was taken. Centre: Roman Ostia, Isola Sacra, and Portus. See p. 237 and Fig. 23.  
*Crown Copyright Reserved.*



describe the evidence for the buried streets with much greater certainty than before. The following observations are based on a close study of their distinctive lineaments on the ground.

The surface markings which, it is believed, indicate streets beneath them are in all cases exactly parallel with the *Cardo*, and run north-south. About 30 parallel lines across the city can be counted and they are distributed throughout all four quarters of the city's plan. In all cases they are approximately the same distance apart; calculated from the air photographs this distance is c. 130 feet.<sup>1</sup> When the interval between these markings is measured on the ground, from the centre of one to the centre of the next, the result is the same. And we can now point to confirmation from five partially excavated streets (Fig. 21, A to E) in the quarter that lies south-west of the crossing of the two main axial streets. It is certainly noteworthy that this width of c. 130 feet is the same as that between several of the streets bounding the long narrow blocks in the western half of the street grid at Cosa (see p. 227) founded in 273 B.C. as a Roman colony,—the same year in which Paestum likewise received its own. One forefather of this kind of plan may be seen in the Hellenic city of Olynthus<sup>2</sup> on the Greek mainland, more than a century earlier; on the North Hill, the long thin blocks had a width of c. 137 feet, when measured from the centre of one street to the next parallel, like that at Paestum.

Let us concentrate on the centre of the city, and see the confirmatory support that has been given by data from excavation and from field-work, which substantiate the air photographic interpretation of a comprehensive street-plan.

The vital proof has been given by the excavated streets recently cleared, which exactly coincide with the marks previously seen on the ground. In 1953 we noted that grass- and soil-marks continue from the lines of the excavated streets, as a direct extension of them.

In 1945, when the air photograph on Plate 52 was taken, only a short sector of the first of the parallel streets to the west of the *Cardo* had been excavated (marked A on Fig. 21). On the ground its width is 15 feet (or 9 feet between the kerb stones), and it lay c. 140 feet beyond the *Cardo* (measuring from centre to centre of each). Excavation has also proved that street A continued northwards on the opposite side of the *Decumanus*, keeping the same alignment, but the portion which was excavated on that side<sup>3</sup> has since been refilled. In the

<sup>1</sup> As measured from the centre to centre, as far as could be judged. The 'spreading' or diffuseness inherent in such linear markings naturally produced small variations in the distance between them. These intervals were originally measured from the air photographs alone, with the known lengths of the temples as a standard for comparison. The results were very accurate. It is also worthy of note that, using only the photographic scale, quickly calculated from the simple formula relating height of aircraft to focal length of camera lens, the plan-dimensions of the temples were obtained correct to within 3 or 4 feet.

<sup>2</sup> D. M. Robinson, *Excavations at Olynthus*, vol. XII, 1946. Cp. also Wycherley, *American Journal of Archaeology*, 1951, 231 seq. At Olynthus the house-blocks measured c. 116 English feet in width, with a basic street width of 17 feet. Cp. *Olynthus*, II, 95.

<sup>3</sup> The appearance of this narrow street, now filled-in, can be seen in a photograph in F. Krauss's *Paestum: Die Griechischen Tempel*, 1943 (Plate 4, foreground).



last year or so the appearance of this zone has changed a good deal, as I have said. Trial digging (over the area<sup>1</sup> marked on Fig. 21) has revealed portions of four more streets further west, set at regular intervals and coinciding with the positions indicated by the parallel markings which the air photographs show. In 1953 I measured between streets A-B, B-C, C-D (E is covered by a dump of excavated soil), and from centre to centre the distances were approximately 130 feet in each case. Street A has a paving of big polygonal stone slabs like that of the *Cardo*,<sup>2</sup> but the others seem to lack it. All are lined with Roman buildings,<sup>3</sup> and in street B (at the point where it meets the *Decumanus*) these buildings had finally spread over the road, blocking it entirely. The buildings along these streets are too complex to describe in detail, and in any case these excavations are suspended and have yet to be published.

Although regularly spaced, these streets are not mechanically uniform. Thus street C averaged  $17\frac{1}{2}$  feet wide (13 feet between the kerbs) (see Plate 53a) and street D averaged 16 feet ( $11\frac{1}{2}$  feet between the kerbs). Outside the excavated area, the continuation southward of the alignments of these streets could be distinguished on the ground in 1949 and 1953 by surface markings. These sometimes took the form of a 'soil-mark' which consisted of an abnormal quantity of stone fragments, roof tiles and pieces of large storage jars, in the surface soil; elsewhere characteristic blocks of dressed stone from walls or kerbs protruded through the weedy grass or stubble. Plate 53b shows an example of the latter feature, on the continuation of street C across the next field. Our inspection of the western half of the city showed that the fundamental causes of the markings seem always to be the same, producing a light-toned streak across the soil, visible both on the ground and from the air. Further west, towards the *Porta Marina*, the ground is also covered with traces of building débris and pottery; and the soil in the zone north of the *Decumanus*, through which the alignments of streets A, B, C, D, E, etc., continue as surface markings is also crammed with building débris. Measurements between these parallel markings likewise come to *c.* 130 feet.

It is, of course, quite probable that the original planners took as their basic unit the width of the blocks of buildings, exclusive of the streets. In that case we ought to deduct from our measurement of 130 feet a distance of *c.* 16 feet (i.e. twice half the average width of a street), thus arriving at units *c.* 114 feet wide. Now it happens that 116 English feet equal 1 *actus*, a standard Roman unit of linear measurement. The correspondence deserves to be carefully examined (see p. 226). In any case, what were the generic origins of the *actus*?

<sup>1</sup> Krauss gives a ground photograph showing this area as it was when my air photograph was taken (*op. cit.*, plate 3, middle distance on right), and its relation to the '*Cardo*'.

<sup>2</sup> Near the east end of the Forum (fig. 21) two streets have been excavated, on opposite sides of it; these streets run on exactly the same alignment and are parallel with the *Cardo*. It should be significant that the position of their line falls in accordance with the regular intervals of spacing detected between the other streets on this axis.

<sup>3</sup> Prof. Sestieri confirms that some of these are of the Republican period.



In other parts of the city the amount of building débris in the soil can produce a *crop mark*, due to crop-failure. Thus in the eastern half of the city in August 1949 we noted long, bald lines across fields of lucerne at the places where the air photographs indicated parallel streets. Not only had the crop of lucerne failed to grow properly, but also there was a correspondingly greater growth of weeds, notably of tall 'fleabane' (*Erigeron bonariensis* L.) which was in flower at the time. (This plant was kindly identified by the Royal Botanical Gardens at Kew, to which we dispatched specimens). Thus, the long straight lines stood out in colour also. But it is not always as easy as this to see the alignments on the surface; it depends on the condition of cultivation or crop. For example, in September 1953 we could see no traces at all of the parallel markings in the S.E. quarter of the city, as the conditions of cultivation were unfavourable,—in spite of the fact that we knew precisely where to look for them on the ground.

At several points, existing hedges, walls and field-boundaries follow the ancient street alignments. This is partly because building débris has been cleared off the fields and dumped along the lines of rubble that were there already, thus having the effect of petrifying them still further and turning them into convenient boundaries for peasant cultivators (as at Zara, p. 180). Some of the markings indicative of streets can be traced all the way from the Decumanus across to the city wall, and some can be traced on either side of the Decumanus, keeping precisely the same alignment from north to south. It is true that the lay-out of modern field-drainage systems and peasant strip-fields occasionally resemble, although only very superficially, these markings. But most of the traces of parallel markings seen at Paestum have that ancient weather-beaten character and typical small irregularities which are unmistakably old. In 1956 I discovered from air photos a similar buried street-plan at Metapontum, a Greek colony.

It is certainly curious that the air photographs do not show clear traces of buried streets from east to west. It is possible that on this axis there were narrow lanes. Only excavation will give the explanation.

There is plenty of evidence on the ground that the built-up area within the city was very extensive. But only further excavation can decide the first origins of the buried streets that have been demonstrated from the air. The detailed relationship of the Roman street plan to that of the Greek colony is not yet clear to the excavators,<sup>1</sup> and an essential step, now, is to dig *below* the Roman street-

<sup>1</sup> In studying the long thin insulae at Paestum it is worth recalling, as a general comparison, those in the plan of ancient Naples, of similar width (Haverfield, *Ancient Town Planning*, 1913, pp. 100-102 and fig. 20), and those in Regio VI at Pompeii.

Research on Classical town-planning, subsequent to Haverfield's book has been summarised suggestively in Prof. Axel Boëthius's 'Roman and Greek Town Architecture', *Göteborgs Högskolas Årsskrift*, LIV, 1948, pp. 3-22. By the 4th century B.C., regular Greek town planning was 'ready for international distribution to the Hellenistic world'. Prof. Boëthius has dealt further with the subject in *Acta Instituti Atheniensis Regni Sueciae*, 1953. See R. Martin, *L'Urbanisme dans la Grèce Antique*, 1956.



levels which have been exposed, and to stop only when the undisturbed natural rock is reached. And, to emphasise a practical point, this should require the removal of *no more than a few feet* of extra depth below the surface of the Roman roads (already robbed of their metalling in many places), in order to reach the level of bed-rock. Prof. Sestieri, commenting on my observations and on the data on Fig. 21, tells me that he considers that the pattern of the streets, at least in the western part of the town, is earlier than the Roman colony of 273 B.C. He thinks that those parallel to the *Cardo* were Greek in *origin*, and that the Romans limited themselves to abolishing some of them while preserving the original plan. But this view requires proof from deeper excavation, as I have emphasised. In any case, Paestum's street-plan is likely to have an important bearing on the study of the transmission of the idea of regular Greek town planning to Italy, and its eventual re-development there in a typical Italic form as the hellenized Italic town. Sestieri himself points out that little indeed of the civil area has been excavated up to now at Paestum, but the recent rapid progress there under his direction justifies the hope that much more will be done before long to solve the important problems of the street-plan, with a definitive publication.

To conclude, a few points can be assembled. On the face of it the buried streets revealed from the air are Roman but may have earlier antecedents. It is possible that working Italic traditions<sup>1</sup> contributed to form the layout. This does not at all exclude the views of Haverfield and others that regular town-planning in Italy was connected with the so-called Hippodamian layout of the Greek towns. One would expect a fusion in the peninsula, combining indigenous and intrusive ideas. A neighbouring parallel for Paestum is suggested by ancient Naples, with its oblong blocks. But it is difficult to make useful comparisons until we know in what way the long *insulae* at Paestum were divided on the east to west axis. The building of house-blocks with a width in terms of a scale approximating to c. 115 English feet (c. 35 m.) has, however, a greater antiquity behind it. We have noted the example of the Hellenic city of Olynthus, and it was a basic unit also for the width of the house-blocks of Priene in Asia Minor founded about 350 B.C., and the same is true of the house-blocks of the Hellenistic plan at Dura-Europos exported as far as the Euphrates about the turn of the fourth and third centuries B.C. Even Etruscan Marzabotto has examples. In all comparisons we must remember the variations regionally in the 'foot' unit.

It is, therefore, excavation with close attention to stratigraphy, and not comparative geometry, which will establish the place of Paestum in the origins of the evolution of town-planning in Italy. In the debate on the relative influence

<sup>1</sup> Or even Etruscan influence at second-hand. The case for Etruscan influence in early town-planning in Italy has been well and justly put by Prof. F. E. Brown, *Cosa*, i, *History and Topography*, 1951, 108, with a summary of references to Etruscan Campania, stressing a possible instance in the plan of early Pompeii.



of Greek and Italic ideas in the peninsula, Paestum seems destined to play a vital part,—and these aerial discoveries are a means of clarifying it.

### COSA AND ITS HARBOUR

The air photographs of Cosa make an apt comparison with those of Paestum and form a logical sequel. If I describe them in some detail it is because Cosa gives such a clear, compact and interesting example of the use of air photography in demonstrating the character of an ancient seaport possessing varied and unusual features.

This early colony of Rome lay 86 miles (by the present road) north-west of its parent city, magnificently sited on a coastal headland near Orbetello. Details of the gridded street-plan on the hilltop have been disclosed by Professor F. E. Brown's systematic excavations,<sup>1</sup> begun in 1948. The results obtained have made these excavations among the most valuable in the whole Mediterranean in recent years.

A thin covering of trees makes it difficult to identify the streets from the air with certainty, but it is possible on Plate 54 to pick out the straight, sunken lines of several of them and the raised relief of the *insulae* between.<sup>2</sup> Yet it would have required considerable confidence to have interpreted them from the photographs alone, good though these are. But now that we have a reliably excavated and tested example, it should be possible in future to be more positive in the air photographic interpretation of other abandoned city sites of this period in Central Italy.

But the value of Plate 54 lies also in its pictorial demonstration, in one comprehensive view, of the site's topography. This possesses an unusual importance, both as an example of an early Roman foundation with a known date and as an illustration of the ingenious engineering displayed in harbour works in the Republican period. In 1947 and in 1950 I went over the ground carefully with the photographs in hand.

The limestone mass of Cosa hill is 373 feet above sea level, at its summit. Though difficult enough of approach to be defensible, it was not too high to be accessible,—the kind of siting much favoured by early town dwellers round the

<sup>1</sup> *Cosa, I. History and Topography; Memoirs of the American Academy in Rome*, Vol. XX, 1951, pp. 1-113. My quotations have been taken from this volume. For a summary of recent work at Cosa, up to 1952, see *Antiquity*, June 1953, 102-3.

<sup>2</sup> The streets marked M, N, O, P, and Q on Map III at the end of Professor Brown's Report can just be identified from the air, prior to excavation, on my Plate 54. This is a wartime R.A.F. vertical photograph. Others, from a different series, were most effectively used in his Report. I am very grateful to Professor Brown for past opportunities of discussing various points.

In examining a site of this kind it is essential to use a stereoscope (with 'stereo pairs' of air photographs, see Chapter I), through which the importance and significance of slight differences of relief become much more apparent and intelligible. It cannot be too strongly emphasised that it is not enough to examine a single vertical photograph if satisfactory interpretation of such slight, but fundamental, differences of relief is to be achieved.

Mediterranean. Inland it directly overlooked the narrow valley that carried the ancient coastal road that became the Via Aurelia, and seawards there were attractive anchorages at hand especially in the long lagoon (now the partly-drained Lago di Burano) at the foot of the hill. And this was solidly backed by a good cultivable belt of coastal plain.<sup>1</sup> Prior to Professor Brown's meticulous excavations the town had long been thought Etruscan.

'Cosa was a Latin colony of, we may presume, the normal 2,500 or 4,000 families,—a minimum of 7,500 or 12,000 settlers in all'. Rome's conquests

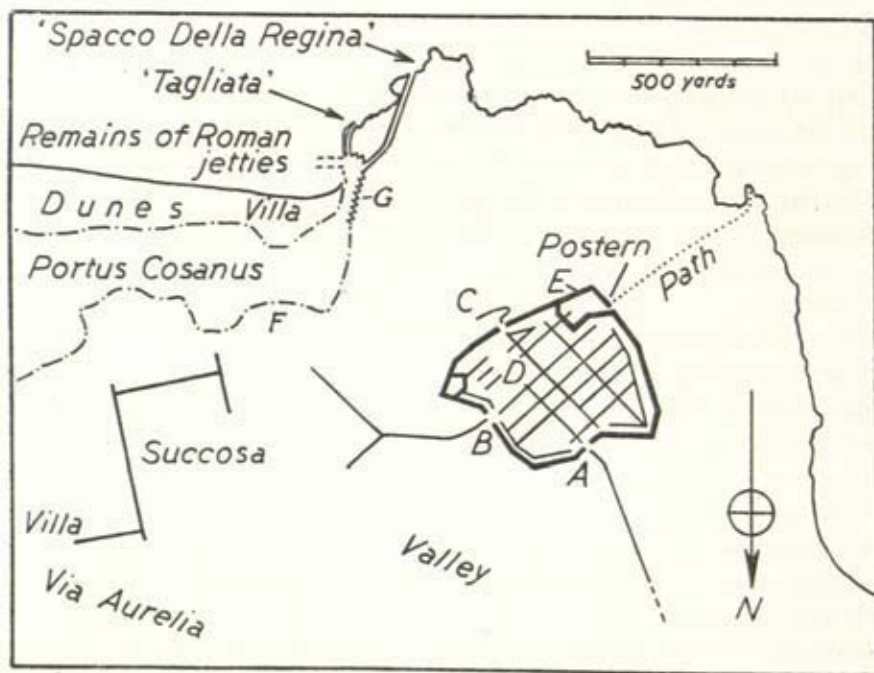


FIG. 22 Cosa. The silted Roman port (shown thus - - - - -) and the rock-cut sluiceways built to free the entrance from silt. A Roman colony was founded on the hill in 273 B.C. Excavations have revealed the gridded town-plant, etc. A B C, gates; D Forum; E Arx; F small temple; G cliff-face artificially scarped. See Plates 54-5.

hereabouts were thus secured by the planting of her first colony in Etruria proper. The choice of site also displayed her increasing interest in sea power. The foundation of Roman colonies at Cosa and Paestum, in the same year in newly seized territory, reflects this growing attention to naval matters. And, indeed, as we shall see, very considerable care was taken with the harbour at Cosa.

<sup>1</sup> Some traces of centuriated roads and Roman land-partition have been found. Dr. F. Castagnoli has been working on this and I should like to thank him for information. Further particulars about Cosa's road-system are to be published in the *Memoirs of the American Academy in Rome* for 1956.



The well-preserved walls, which clearly outline the town from the air, are formed of massive polygonal blocks of dressed limestone. An area of c. 34 acres was enclosed. Excavation has given evidence that the town wall was built during the first half of the 3rd century B.C.; and in all probability in the first years after the foundation of 273 B.C. This reliable dating will be of particular importance in the study of the impressive series of ancient town walls in polygonal masonry so famous in central Italy. 'Cosa is of the series but typologically late in it'. From its three gates (A, B, C, on Fig. 22) ancient roads descended the slopes. Two are visible on this photograph. A street followed the inner circumference of the wall; most of the town was covered by the grid of streets which enclosed narrow rectangular blocks of houses.

'No influence of ritual or other theoretical consideration is discernible. The streets were laid out so as to take the utmost advantage of the natural contours', being aligned N.E. to S.W., and N.W. to S.E. 'Their distribution over the site was determined by the approaches from outside, themselves dictated by local topography, and by the positions of the Forum and the Arx' (Fig. 22, D, E.). For the position of the Temples, Basilica, etc., the reader should consult the excavation report. There is a refreshing and convincing quality of practical common sense displayed by this plan, set out by hard-headed colonists, and given full weight by its excavator's interpretation of it;—a welcome relief from the mysteries so often conjured up on slight evidence and woven round new foundations of this kind. I mentioned earlier (p. 224) that we now know that the average spacing (130 feet) from the middle of one street to the next in Cosa's western quarters resembles that found in Paestum's street-plan.

At the foot of the hill lay the Port, a land-locked lagoon. The Roman ship-channel from the sea entered it near the point where the modern drainage canal from the Lago di Burano has its mouth.<sup>1</sup>

The present belt of sand-dunes along the shore was probably already in existence. On a little hill overlooking the Port stood a small temple (Fig. 22, F.) whose divinity protected Cosa's commerce. The small harbour was in many ways ideal for ancient shipping, being enclosed, sheltered, shallow and under the eye of Cosa-on-the-Hill. Behind this, as time passed, a small market settlement grew up, named *Succosa*.

But there was one disadvantage, which was to prove fatal. Sand continually threatened to block the channel mouth. The efforts to counter this, dating from the flourishing early period of the town, are an extraordinarily interesting episode in Roman engineering. Two successive works were constructed to bring in a sandless tidal current to scour and disperse the sand which was silting up

<sup>1</sup> Perhaps a natural outlet existed at this point, as Professor Brown suggests. It was improved by vertically scarping the rock face above the entrance channel at the base of the hill to a height of 25-30 metres, for a distance of c. 140 metres (see Fig. 22, G.).

For another ancient harbour which is now silted up but still well preserved in shape, see *Emporion* (*Ampurias*) in N.E. Spain, a Greek trading station from the 6th century B.C. and a Roman town; Antonio Garcia y Bellido, *Hispania Graeca*, 1948, esp. p. 19 (map).



the entrance to the harbour. Later, breakwaters were employed. Parts of these survive, submerged in shallow water or embedded in the modern beach.

Professor Brown has skilfully disentangled the archaeology of the Port, its channel and entrance works. The air photographs very usefully illustrate their topographical setting; for at ground-level it is not easy to visualise the relationship of all these features, nor to appreciate how practical and sensible were these attempts to solve the local problem.

The first two schemes were based on sluiceways, well-known today as the Spacco della Regina and the Tagliata (once thought to be Etruscan). The former, and older, was a natural cleft caused by a fault in the limestone promontory, giving a narrow opening 260 metres long and from 1 to 6 metres wide (Plate 55). Its outer exit faces the open sea, the inner one debouches opposite the mouth of the original channel into the *Portus Cosanus*. Its rock walls were carefully hewn to the perpendicular, obtruding angles were cut away, and its bed was levelled to facilitate in-flow. Now, it is blocked by fallen rock and the sea has broken through one side. 'One or other of these catastrophes dammed it in antiquity. Its successor was the Tagliata, wholly artificial, but constructed on the same principle'. This 'New Cut' was 70 metres long, 4 to 5 metres wide, and separated from the sea by a thin wall of natural rock (Plate 55). Its seaward end was placed in deep water beyond the risk of silting. Originally it was even equipped with rock-cut sluice gates. Later a second seaward mouth was added, to increase the force of the entering scouring water. All these details of construction are of the greatest interest and appear most clearly on the excellent ground-photographs taken by Professor Brown. But even the pair of projecting breakwaters, subsequently built to keep open an entrance-channel c. 20 metres wide, failed to save the port. Their remains, partly submerged, are still visible at the point where the modern drainage canal (re-using the Roman rock-cut channel, G) has its narrow protected mouth.

By early Imperial times a big 'villa' had been built, overlapping the area of the old harbour which must have been silting up. By now the Tagliata, too, was out of action. Already by then the great estates were crowding out and absorbing the original small-freeholders throughout the surrounding countryside. Life ebbed from the early settlement on the hill, as in other early towns in the Maremma, and by degrees shrunk into the small satellite *Succosa* down in the valley beside the Via Aurelia. In this decline malaria was probably both a cause and effect, closely connected with the progressive stagnation of the coastal lagoons. By the year 416 Cosa-on-the-Hill was an archaeological site, a desolate ruin as Rutilius saw when sailing by.

But all was not quite over. Humble survivals are as much the concern of archaeology as the heyday's prosperity. A spark of life flickered briefly in the 11th century round a church or monastery among the ruins of the Capitulum, on the hill-top. Looking at the air photographs and studying its setting, one is able to picture well the tiny communities in remote corners that peopled the



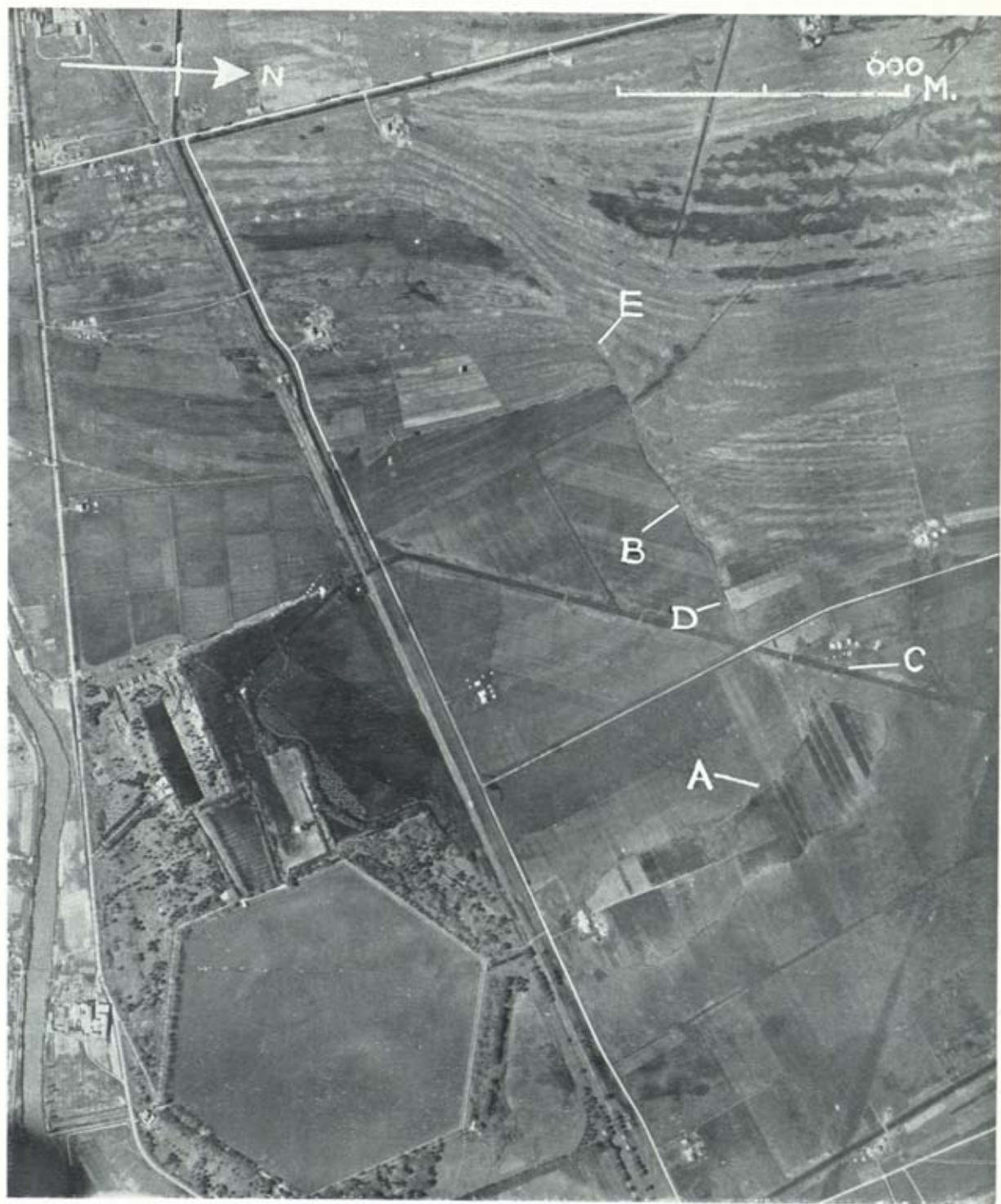


58. OSTIA. Vertical air photo (1944) of the excavated street-plan of the Roman town, with the Tiber and its ancient course on the right (A). Its coast-line was approximately parallel with the oblique line of the road in the upper left corner. See Fig. 23 and p. 239. *Crown Copyright Reserved.*

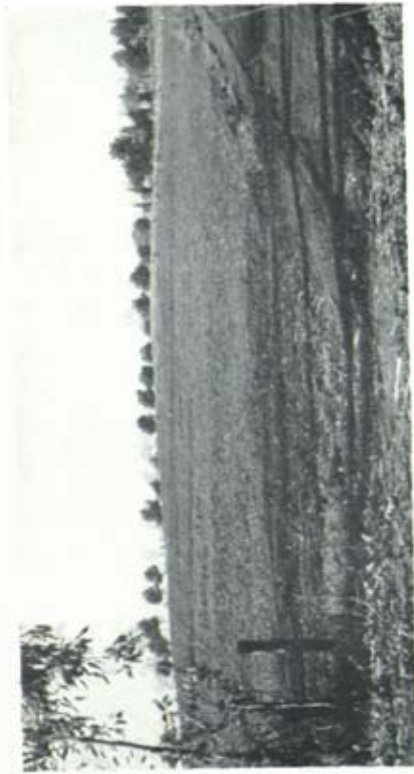


59. OSTIA. Vertical 'photo-mosaic' to illustrate the topography of the Roman coast-line. A-A= Post-Roman sand-dunes. *Left*: 'Piana Bella'. *Centre*: Roman Ostia. *Right*: Isola Sacra and Fiumicino. NB. The straight white lines at the south end of the 'Piana Bella' are modern. See p. 242 and Fig. 23. *Crown Copyright Reserved.*





60. OSTIA: the CLAUDIAN harbour, now inland. A uniquely clear picture of its outlines, resulting from coastal flooding by the German army in 1944. Earthworks mark its buried moles (A, B); entrance (C) and probable position of the pharos-island (D); the above-ground limit of the left mole (E). *Bottom left*: Trajan's harbour and the Fiumicino Channel. See p. 248 and Fig. 23. *Crown Copyright Reserved*.



61. OSTIA. (a) *Top left*. Centre; looking north-west along a broad earthwork, the site of a buried road, where it leaves the south side of the city. See Fig. 23, road A. The rising curve on the horizon shows its profile. (b) *Bottom left*. Looking SE. along the sunken line which corresponds to the original big bend in the Roman Tiber NE. of Ostia. On left and in foreground, the former river bank; the figure stands in the bed. (c) *Top right*. The Claudian harbour; the ground remains of the left mole. (d) *Bottom right*. Middle distance: Shadow-relief shows a slight bank, one of the parallel lines of ancient sand-bars west of the Claudian harbour. Air photos show their alignment more clearly (Plate 60). *Phs. Bradford, December 1954.*



early Medieval landscape, some to thrive and some to perish. By this time the site was called *Ansedonia*. Later, a small feudal fief (at times hardly distinguishable from a nest of brigands) set up its petty power here, during 'the false renaissance of the thirteenth century',—as Professor F. E. Brown justly terms it. I have outlined elsewhere<sup>1</sup> the archaeological evidence (including air photographic discoveries) for a similar transitory spurt of activity in Apulia at this time. The excavations at Cosa have made a welcome addition to the study, too much neglected, of the field-archaeology and pottery of earlier Medieval Italy. But Cosa's 'brief candles' were finally snuffed out in a shower of sparks by a Siennese army in 1329, and the hill-top was left to the bats and owls.<sup>2</sup>

### CARTHAGE: THE PORT

Although this book is primarily concerned with ancient topography in Europe, the coast of North Africa is by nature brought within its province. Again and again, Human Geography, since prehistory, has presented the Mediterranean as a great lake whose shores to a large measure shared common ground in ecology and daily life, an element of unity underlying diversity in creeds or politics. At times the peoples of its northern shores have been deeply drawn into Africa and the Near East, and at others the southerners have crossed the 'lake' and have made their presence sharply felt in Europe's flank. Even with recent changes in the centres of power, the interplay of Continents in this arena is likely to remain one of the fundamental themes of history. And so, when we witness the Greeks and Romans reaching over to lay their hands on North Africa (as if by instinct, but prompted by a sound grasp of affairs), we must follow suit. It is no accident that we have already turned to Tunisia (p. 193 seq.) for a particularly clear picture of a characteristic type of Roman landscape which originated in Europe.

In other ways, too, it is helpful to compare 'the other side of the street'. A very interesting study<sup>3</sup> can be made by a detailed comparison of the lay-out of the ancient ports in the Mediterranean, and their characteristics and evolution. Behind the Roman engineering feats at the little port of Cosa and the ambitious artificial basins at Ostia, illustrated in this chapter, stand the fore-

<sup>1</sup> *Antiquity*, June 1949 and June 1950.

<sup>2</sup> Dennis, *Cities and Cemeteries of Etruria*, II, 1878 ed., 245-62, gave an excellent description of the site, which in his day was still masked by a protective jungle of undergrowth.

<sup>3</sup> Cp. Lehmen-Hartleben (*Die antiken Hafenanlagen des Mittelmeers*), *Klio* mon. XIV, 1923. Air photography has since shown that we can add greatly to earlier knowledge of ancient port plans; methods, and examples of discovery, have been outlined above, p. 41. The results of the aerial study (combined with sea-divers' reconnaissance) of the submerged traces of the ancient port of Tyre are famous (see A. Poidebard, *Un grand port disparu: Tyr*, 1939). From Tyre according to classical tradition, sailed the Phoenician founders of Carthage. The whole study of ancient ports on the coasts of Phoenicia and the Levant is very relevant for that of Carthage, and it has recently been re-examined most ably by Poidebard, Lauffray and Mousterde, in the light of their discoveries from the air at Sidon (*Sidon. Aménagements antiques du port de Saida. Etude aérienne, au sol, et sous-marine*, Beyrouth, 1951).



runners and prototypes; and the keen eyes of all sailors have always been alive to drawing practical advantage from the experience of rivals. Of these predecessors I have space only for one,—Carthage, with its famous ports which have not hitherto been adequately illustrated by air photography (Plate 56).

The air photographs (from a series in November 1943) were not taken with archaeological needs in mind, but they show clearly the topography of this most ancient naval base with its artificially excavated basins, which now lies close by the little railway station of Salammbô. The photographs also help in planning and locating the important ancient structures along the shore which stand in shallow and clear water, and often protrude above it. These victims of destruction and coastal erosion have in most cases been only superficially planned, and much more could profitably be discovered about them. For this kind of work, vertical air photography from a really low altitude of about 1,500 to 2,000 feet would be a suitable technique (giving a much larger scale than Plate 56), and there is a conveniently placed airfield at El-Aouina, still in active use today and only 3 miles from the centre of Carthage.<sup>1</sup> During the war I examined the coastal remains from the air and on foot, at a time when, by an irony of Fate, we were stationed at Carthage to plan the invasion of Italy.

The topographical study of the Punic city is notorious for its difficulty, due in part to the savagery of its Roman and later destroyers, to frequently bad excavation and wild theorising in the past, and in recent years to the 'rash' of suburban villas and speculative building which has covered many vital areas in advance of their examination, and continues to do so (see Plate 56). It is disturbing to realise how patchy is our factual knowledge as compared with the endless hypotheses, after so many years. However, there is always reliable counsel to be found in Gsell's admirable and meticulous survey<sup>2</sup> of the evidence, which is the starting point for all future work.

The present indications are that the foundation of Carthage may, in fact, be put at about the traditional date of 814 B.C., although that coast was known to the Phoenicians still earlier. The problems concerning its ports are among the most vexed in all Classical topography, even more so than at Ostia, and on some matters there has been little progress since Falbe's famous map and pioneer survey in 1830.

<sup>1</sup> At appropriate seasons of the year it is possible that crop-marks and soil-marks could reveal the outline of a number of buried buildings and perhaps traces of the city's inland walls. On air photographs I have, in fact, observed a few ancient features made visible thus. But Carthage is to some extent a difficult site for these forms of discovery, as prolonged cultivation has often spread a good depth of soil over the foundations, and irrigation from wells minimises some of the archaeologically-useful effects of drought. There are hopeful areas of arable fields behind the belt of houses along the coast. Perhaps the evidence will be forthcoming from the excellent photographs already taken for the aerial survey of Tunisia organised by the Institut Géographique National.

<sup>2</sup> *Histoire Ancienne de L'Afrique du Nord*, vol. II, 1920. Among later works, the most helpful for the study of the plan is the article by D. B. Harden, 'The topography of Punic Carthage', in *Greece and Rome*, October 1939. Lapeyre and Pellegrin, *Carthage Punique*, is also useful, especially for the history of exploration here. Mme. Colette Picard (Conservatrice du site de Carthage) has a good bibliography in her archaeological guide, *Carthage*, 1951, but her plan (Plan II) of the ancient harbours is not entirely accurate.



We know, of course, that the two basins are artificial (although they may have had an origin in natural lagoons); we know that they were in Roman use; we know, too, that they correspond with Appian's description of the Punic harbours. But we are ignorant of how far Roman hands changed or retained their dimensions, nor do we even know when the Punic ports were built. Gsell (p. 57, n. 1) suggested that they would have been necessary in the 6th century B.C., but there are also facts in favour of earlier and later centuries (cp. Harden, and Lehmen-Hartleben).

The aerial plan on Plate 56 usefully establishes a precise record of the state of the ports in 1943-4, and should assist the reader in a fresh approach to these complex questions. It is wise to begin from the fact that we cannot expect to see every topographical feature in agreement with Appian's account. In less than two centuries the Augustan *colonia* on this site rose to be one of the chief cities in the Empire, and the facts show that this rich Roman metropolis was a more powerful and thorough agent of destruction of the remains of Punic Carthage than even Scipio's army was. One result of the aerial study of the port-area has been to emphasise that there is only one solution to our problems here:—by systematic excavation with modern standards. Without it, further attempts at correlating topography with the historical texts cannot make progress. Excavation and air photography at the ports of *Utica* and *Tipasa* is the natural corollary.

Gsell and Harden have assembled the topographical references to the Punic port in classical authors. It is clear from these that the outer, sub-rectangular basin was for mercantile shipping and the inner circular one primarily for warships. The term *Cothon*<sup>1</sup> was anciently applied to the port. The most famous description is that by Appian (floruit A.D. 140), which was based on the earlier observations of Polybius, an eyewitness of the siege and destruction of 146 B.C. The gist of his account is as follows.

The harbours communicated with each other, and the entrance into them from the sea was 70 feet wide and could be closed with iron cables. The first port was for merchant shipping and here was collected all kinds of ship's gear. In the middle of the inner port was an island, and large quays were set at intervals round this harbour and the island. They were equipped with slipways which had capacity for berthing 220 vessels, and above these were storage chambers for their tackle. Two Ionic columns stood in front of each slipway giving the appearance of a continuous portico to both the harbour and the island. On the island was built the admiral's house or headquarters from which trumpeters gave signals, heralds gave orders and the admiral supervised everything. The island was in front of the entrance into this inner harbour, and the admiral's

<sup>1</sup> *Cothona sunt portus non naturales sed manu et arte facti* (Servius). Cp. J. I. S. Whitaker, *Motya*, 1921, on his excavation of the small rectangular 'cothon' (36×50 metres), artificially dug out at Motya in Sicily (esp. figs. 22-3 and plan E); and references to other possible 'cothons' on the N. African coast (p. 188), promising subjects for air photographic discoveries. British excavations at Motya are reported in *Antiquity*, June 1956.



house rose to a good height so that he could observe what was going on at sea, while those in the sea outside could not spy clearly into the interior of the port. Not even incoming merchants could see the docks at once, for a double wall enclosed them, and there were gates which made entry possible from the outer harbour into the city without going through the dockyards.

The original is not without disputed readings, but the sense is mainly clear. In other passages, Appian gives further clues in his account of the siege,<sup>1</sup> and he describes the mole built by the Roman consul Scipio across the entrance to the port (which he says faced towards the west) to stop blockade-runners. But it is generally agreed that the entrance, which led first into the mercantile port, was near the tip of the Bay of Kram and opened to the *south* rather than the west. Both Harden and Gsell offer reasonable explanations of this discrepancy.

Even today (in spite of subsequent destructions and reconstructions) the symmetry of the circular harbour and island is very impressive from the air, not for size alone as much as for the simple boldness of the design, and for that absorbingly interesting combination of intense formalism with a revolutionary novelty which characterises so much planning in the Ancient World. We can estimate that the circular harbour would have been *c.* 1,000 feet in diameter and the outer oblong harbour *c.* 1,600 × 1,000 feet. The sea and the 'Sanctuary of Tanit' set limits to the latter, but systematic excavation is needed. It is still not yet practicable to calculate by measurements the port's capacity in terms of ships. And, even more regrettable, its administrative buildings are still a matter of mystery. It would be useless to pretend that the existing archaeological knowledge of the structures on the limited and vital area of the island is better than painfully inadequate. Beulé (1859) and Merlin (1908 and 1911) believed that their trenches had confirmed Appian's details of it, but Gsell and others were highly critical. The chief problem is to distinguish between remains of some fragmentary Punic structures on the island and early Roman reconstructions (probably re-using some earlier materials). Insufficient attention to stratification has made the whole problem unnecessarily difficult, and the large blocks of concentric walls and fragments of columns are still not securely dated. Fortunately, however, a portion of the island remains as yet intact and un-excavated.<sup>2</sup>

The air view gives a further opportunity of considering another disputed feature—i.e. the immense area of foundations now awash in the sea at the tip of the promontory (Plate 56, top left) which forms the north limit of the Bay

<sup>1</sup> *Libyca*, VIII, 121-125.

<sup>2</sup> Falbe's map of 1830 (e.g. see Tissot, *Géogr. Comparée de la Province Romaine de l'Afrique*, i, 1884, map on page 600) showed the island as completely detached except for the narrow isthmus on the north. Falbe marked (no. 42 on his plan) a possible entrance to the rectangular port from the south,—in the form of a broad sandy depression connecting it with the north side of the Bay of Kram,—but this alignment was filled-in later in the 19th century.

Claims have been made for traces of a submerged mole in the south part of the Bay of Kram (i.e. for an outer harbour, or the mole of Scipio); see Courtet, *C.R. de l'Acad. des Inscr. et B.-Lettres*, 1897, 125-8; De Roquefeuil, *ibid.*, 1898, 20-39; Hantz, *ibid.*, 1900, 55-70. But submarine explorations in 1948, directed by Poidebard, found only traces of natural rocks along this line; *ibid.*, 1948, 380.



of Kram, adjoining the mercantile basin. Archaeologists should be cautious about them. These foundations have a quadrangular outline, first recorded by Falbe in 1830. The frontage along the shore measures *c.* 300 m. and its frontage in the sea *c.* 425 m.; the margins are marked by big blocks of squared stone, and parts of the interior contain rubble *débris*. There are minor walls of Roman or Byzantine date along the shore. On suitable air photos (see Pl. 56) such submerged foundations have a distinctive appearance,—as a black band caused by the growth of seaweed clinging to the blocks of stone (but equally, of course, to natural rocks also).

Falbe, Dureau de la Malle (1835), Gsell (II, 30-78), and others considered that this quadrangular outline represents the remains of the Punic *χωμα* described by Appian as 'The wide quay which had been built in front of the city wall, for unloading merchant ships, some time before'.

True, a broad quay or *χωμα*, near this spot, certainly played a vital part in the final stages of the siege of Carthage, and was fortified by both sides. But there are still a few difficulties, e.g. in correlating the 'quadrilateral of Falbe' with that *χωμα* which was attacked by night by a desperate force of naked Carthaginians who waded through the water to reach it (Appian, VIII, 124); further, shipping would often have been very exposed to winds if anchored here, and the modern soundings show that now there is only very shallow water all round the quadrilateral. However Gsell has provided reasoned answers to these objections. Yet it remains a serious difficulty that we do not know the extent of Roman work in these remains and there must be work of several periods. Also H. P. Hurd (*The topography of Punic Carthage*, Bayard Press, Pennsylvania, 1934) has quoted information given by Caillat (the engineer of the Bey of Tunis) that when the Bey's palace (now called the Lazaret) was built here in 1835 these quadrilateral foundations were '*nivelés, déblayés*' and the materials were used to build roads across the ports. Nevertheless, these quadrilateral remains off-shore were clear enough for the careful Falbe to map them in 1830.

Only a few of the other controversial hypotheses can be mentioned. One was that the entire 'quadrilateral' represents the outline of an outer harbour, and that the long eastern side is only the *débris* of a narrow mole, '*une jetée et non un terre-plein réuni à la terre par un remplissage quelconque*' (cp. De Roquefeuil, *C.R. Acad. des Inscr. et B. Lettres*, 1899, p. 19 map). Another suggestion has been that an exit from the rectangular harbour may be indicated by the curving line (shown as early as 1830 by Falbe) which is taken by the southernmost lagoon and is continued by a depression in the ground which reaches the shore about half-way along the landward side of the 'quadrilateral'. At the southern end of the 'quadrilateral' traces of a mole projecting from the shore, measuring 30 m. wide and 120 m. long, have been claimed; and some have even associated this with the mole built by Scipio to close the port's entrance which, according to Appian, was situated a short distance from the land. Whatever proves to be the truth about such speculations,—and they are little more as yet,—the only



proof will come from *systematic and accurate* work which still remains to be done *at ground level!*

Northwards from the harbours, and as far as Bordj Djedid promontory<sup>1</sup>, there are considerable traces of a long line of foundations in shallow water. This follows the shoreline and is particularly clear from the air (Plate 56), but low-level vertical photographs would greatly help with the detail. Gsell (*op. cit.*, p. 35) and Harden believed that the great blocks of stone, of which this line largely consists, are best interpreted as the remains of the Punic city's wall along its seaward side, presumably levelled in deliberate obliteration by the Romans in 146 B.C. Of course, a wall collapsed in the water is much less likely to be removed for re-use by later builders than is a ruined one on land (where, in fact, the above-ground structure of the Punic city wall has virtually disappeared), and this might account for the survival of these remains to the present day. But I think it is very probable that Roman engineers had a big hand in re-constituting most of this line, with substantial patching of the 'quadrilaterals' at each end, and perhaps may have re-used blocks of stone taken from the ruins of the earlier city for the purpose, when clearing the site for the new city at the time of the founding of *Colonia Iulia* in 29 B.C. This explanation helps to resolve the differences between existing views, pro-Punic and pro-Roman.<sup>2</sup> The best policy would be to scrutinize the remains again still more closely. Roman Carthage was apparently not fortified until the 5th century A.D., when the Vandals made their meteoric swoop into Africa. But to Gsell, and others, these immensely massive blocks do not suggest work of so late a period. It may be noted that Dr. Carton believed that he had identified a sector of the Punic walls, of similar construction, along the north shore of the Lake of Tunis,—thus forming the city's southern defence.

The revival of Carthage by a second Roman colony was due to the far-sighted initiative of Caesar, and one was led out c. 44 B.C. after his death. But it was Augustus who reinforced it and successfully established *Colonia Iulia*,—from which time the city grew rapidly to become one of the largest in the Empire. The archaeology of the street plan has been clarified by M. Saumagne<sup>3</sup> after test-excavations. These located a number of streets, giving a basis for a reconstruction of the ambitiously large, and unusual, plan which originated with the Augustan re-foundation. It consisted of some hundreds of small rectangles measuring 120 × 480 R. feet, demarcated by roads,—producing a kind of *limitatio* by *strigae* (for strigation, see p. 212). The longer axis of the rectangles lay north-south, and the general effect resembles the grid formed of small

<sup>1</sup> For a photo of the small quadrilateral here, see Plate 56 (inset), and Harden, *op. cit.*, pl. IIb.

<sup>2</sup> Lantier is of the opinion that this off-shore line is entirely of Roman construction, forming a 'limes maritimus, matérialisé par une ligne de pierres de taille et un épais enrochement, permettant ainsi la formation d'une cadastration rigide', i.e. for the street grid of 29 B.C. See *Jahrbuch des Deutschen Arch. Inst.*, 46, 1931, cols. 488-90.

<sup>3</sup> *Bull. Arch.*, 1924, 131-40; 1928-9, 629-64. See also Lapeyre and Pellegrin, *Carthage Latine et Chrétienne*, 1950, 56-7; and Lantier, *op. cit.*, including Saumagne's reconstructed plan.



rectangles in the much more ancient plan of Rhodes, which I discovered from topographical traces whose significance was made clear by air photographs (p. 278).

Roman Carthage suffered a less total destruction than did the Punic city, but it has been thorough nevertheless.<sup>1</sup> I mention the matter of its street-plan because it brings us back to problems we have been discussing. M. Saumagne holds that the foundations along the shoreline between the 'quadrilaterals' are set parallel with the axis of the *cardines* in the street-plan of *Colonia Iulia* and formed its frontage. He attaches particular importance to the straight sector, now awash in the sea, in front of the 'Thermes d'Antonin' (south-west of Bordj Djedid promontory), and he has made a strong case for the way in which it fits with the subdivisions of *cardines* and *decumani* in the street-plan.

The course of this straight sector is seen on Plate 56 (inset), and a study of the photographs confirms that this particular stretch of foundations lies exactly parallel with the main 'cardo' axis of Roman Carthage. The aerial plan, with its comprehensive view high up above the site, enables the archaeologist to make accurate comparisons between alignments that are distant from one another. Here, for instance, it was possible to use as a fixed control the visible lines of paved Roman streets excavated near the Theatre in the area of villas, dating from the 2nd century A.D., which lie a good distance from the shore.

## OSTIA

### (i) *The city*

We must now return to Italy, and first to the site of Ostia<sup>2</sup> (Plates 57-60). It is appropriate that the port of Rome should follow Carthage in our survey, since the growth of the one and the ruin of the other were counterparts in the bitter rivalry for mercantile supremacy in the Mediterranean. And, further, the artificial harbours built at the Fiumicino mouth nearby (Plate 60), which later 'squeezed out' Ostia's own commerce, compare interestingly with the earlier examples of port-works which we have seen.

Ostia, its attendant sites, and ancient setting, cover so extensive an area that the study of a vertical aerial survey is probably the best way of seeing how the parts fitted together to make a working whole, in the very individual landscape which nature and man created round them. In practice, therefore, Plates 58, 59 and 60 are best treated as a topographical triptych, to be studied as a unity.

The archaeology of the Ostian area is known for its complexity and the present discussion is intended only to be exploratory and selective. For I wish

<sup>1</sup> Hassan the Arab invader destroyed c. 700 A.D. the ports of Carthage to remove the danger of a further attempt at reconquest by Byzantium.

<sup>2</sup> I should like to express my particular thanks to Mr. Russell Meiggs for his generous help and invaluable judgement in all matters concerning Ostia and adjacent sites. I am grateful to Prof. J. A. Steers for advice on the interpretation of the ancient geography of the Claudian harbour, and to the Departments of Geology and Soil Science in the University of Oxford for the use of geological maps.



to confine myself strictly to the consideration of the air photographic evidence as my personal studies have been concentrated upon this aspect, beginning during the War. A number of visits have been made in order to ground-check details seen on the photographs by field-work, my last visits being made in December 1954. My first visits for this purpose were made when 'on leave' during 1944.

But first there is a point of general archaeological importance to be noted. Examination of many vertical photos showed more clearly than any other previous source that an essential key to the ancient topography of this area lay in a feature of its geological structure,—a feature that deeply affected land-form and human settlement. Briefly it is this:—the positions occupied by the *Portus* at Fiumicino, by the original nucleus of the Isola Sacra, and by Roman Ostia with the level 'Piana Bella' to the south, were members of a clearly-defined chain of 'islands' of firm ground (Pleistocene sands), which stretches from north to south. In their subsoil and in their potentialities for human use they are altogether different from the rest of the big arc of coastal plain that lies behind them. Although the interior portion of the plain is only slightly lower than the Pleistocene sands, it is geologically distinct and has an entirely separate origin and composition. It probably once formed a lagoon, gradually filled by silt and plant humus (pp. 245-6). Until recent years it remained very marshy at many points, but land-reclamation has made less apparent its very real difference from the long, narrow, belt of solid ground to which Roman settlement and cultivation were 'anchored'.

It is not too much to say that if these patches of firmer ground had not existed the Ostian congeries of sites would never have developed as it did. The importance of this geological feature is evident in a number of ways (e.g. in its effect on the ancient course of the Tiber), and these I shall mention in turn. The location of this string of small oval 'islands' is fairly clear even on geological maps of a small scale (1 : 1 million),<sup>1</sup> but it is not until the information from geological maps is amplified by the detailed pictorial plan of the terrain on a large scale,—which the vertical photos provide,—that the implications for archaeology emerge fully. There is no doubt that certain of the problems concerning the topography of the Roman landscape at Ostia could well be settled by further close study of the geology, particularly by auger-borings at critical spots.

The new data from the air photos, which have been checked by field-work, principally concern the environs of Ostia:—the wide expanse of the 'Piana Bella' (p. 242), the ancient coast-line and the Isola Sacra (p. 244) and the Claudian port at Fiumicino (p. 248).

<sup>1</sup> For example the British G.S.G.S. map of 1943. The term 'island' is naturally used here in a relative and purely geological sense. See 'Le Pliocène et le Quaternaire aux alentours de Rome', by Blanc, Tongiorgi and Trevisan (pp. 3-35) in reports of the Fourth International Congress of Quaternary Research, Rome, 1953.











62. VERONA. The gridded squares of the street-plan form one of the best preserved examples of a layout of Roman origin. Air photos have been useful in a re-examination of problems connected with the position of the river Adige and bridges in the Roman period, especially so when the water-level is low (as in this photo, April 1943). An ancient channel ran on the line of the 'Acqua Morte', shown by the line of the broad curved street at the centre of the photo.

See Fig. 24 and p. 256. Vertical photo. *Crown Copyright Reserved.*





63. NORTH ITALY, PIACENZA. The Roman street-grid has survived with a notable degree of completeness. This vertical view also gives a good demonstration of the masterful layout of the Roman roads converging on the city. (A) *Via Aemilia*. (B) Road across the River Po to *Mediolanum*, Milan. (C-D) *Via Postumia*. See p. 261. *Crown Copyright Reserved*.





64. NORTH ITALY, PAVIA. A pre-eminent example of the square units of a Roman street-grid in modern use. The crossing of its *Cardo Maximus* and *Decumanus Maximus* at the centre is clearly preserved. The present bridge over the F. Ticino is on the site of a Roman one. Pavia, with its churches and palaces, is an ideal example of the maintenance of urban civilization in Europe,—a rich and powerful regional centre since Roman times. In the 16-17th centuries it was still a key-point, besieged several times: the perimeter of its walls can be traced. See p. 263. *Crown Copyright Reserved.*



65. NORTH ITALY. Examples of fortified towns, with wall and moat, founded in the earlier Middle Ages. *Above (a).* CASTELFRANCO VENETO begun in 1199 by Treviso as an outpost against Padua. *Below (b).* CITTADELLA begun in 1210-11 by the Paduans as a rival to the Trevisan colony. See p. 267. Vertical photos. Crown Copyright Reserved.



But, first, the town itself requires our notice. A vertical photographic plan of the total area now excavated has not so far been published in Britain.

The site of the town, 16 miles downstream from Rome, stood formerly at the very mouth of the Tiber but is now more than 2 miles inland from the modern shore line at Ostia Lido. Plate 58, an enlargement from a British vertical photograph taken on 24 October 1943 at a height of 5 miles, shows the excavated<sup>1</sup> plan of the heart of the Roman town as it appeared in Imperial times. This picture gives, at a glance, the chief features of the whole lay-out, their relationship to one another, the dry bed of the ancient Tiber's course<sup>2</sup> (bottom right), and the position of the shore line<sup>3</sup> (top left) in the city's later days. Good vertical photographs can help considerably to accelerate the surveying and publication of a complex of streets and buildings of this kind.

There is still a large part of the town to be excavated in the area at the top of the photograph and all down its left hand side. In these quarters the deep accumulation of soil above the buried streets limits the appearance of traces which can be detected from the air, although grass-markings and parch-markings may be expected to outline some of the buried streets and structures in spring and summer.

It is well-known that Ostia arose as a small military colony, founded to protect Rome from sea-borne raiders when her own sea-power was still small.<sup>4</sup> When it was built (probably a little before 330 B.C.) this *Castrum* stood only a few hundred yards from the sea to the west, to-day far out of sight beyond 2 miles of dunes. The outline of the rectangular fort, which covered 5½ acres, was preserved in the later street-plan. An interesting explanation has been offered of the unorthodox angled lines of the chief axial thoroughfares of the grown town, the *Decumanus Maximus* and *Cardo Maximus*:—Becatti's suggestion<sup>5</sup> is that these streets perpetuated some portions of the course taken by two track-ways which existed even before the *Castrum* and which converged on the river mouth, presumably at a look-out post and some huts. Although this is a reasonable suggestion it is difficult of proof. In any case it must have been a wild and exposed spot in the 4th century B.C.; even to-day on a bright summer afternoon,

<sup>1</sup> Between 1938-43 the extent of the excavated area was doubled, until about 100 acres were cleared. For a detailed identification of the buildings, see the first volume in the definitive series to be devoted to the site:—*Scavi di Ostia*, vol. i, 1953, *Topografia Generale*; by Prof. Guido Calza and others. Its plan on fig. 36, which gave the state of the excavations in 1949, showed that no further extensions had been made since the date of my Plate 58. See review by R. Meiggs, *Journ. Rom. Stud.*, 1956, 190.

For summary plans of the buildings, cp. Calza's booklets on Ostia in the *Itinerari dei Musei e Monumenti*, 1936, 1947, etc.

<sup>2</sup> Its curving line is followed by a modern field-road on each side; the remains of its steep banks still stand up to 6 feet high. Roman boundary *cippi* have been found on the north bank of that sector of the old course which can be seen on Plate 58. Opposite, the quays and waterfront along the south bank have not yet been excavated.

<sup>3</sup> I.e. where the sand dunes begin, on the further side of the road that leads to Fiumicino.

<sup>4</sup> There are traditions of an earlier foundation by Ancus Martius, third king of Rome. It is very possible that field archaeology will locate a settlement of this, or an earlier period, in the Ostian area.

<sup>5</sup> Cp. *Scavi di Ostia*, vol. i, 1953, 93-5.



and in spite of all the modern land-reclamation, one can still easily recover the character of the antique setting, in the desolate area near the present river mouth.

We are free to assume that the *Decumanus* of the Castrum (and hence that of the later town) was based on the straight line which a pre-existing track from Rome to the Tiber's mouth would have adopted naturally at this point. A more complex problem is presented by the similar (but not identical) alignment of (i) the north arm of the 'Y' in the street-plan, and (ii) the street which bends to the south-east in continuation of the Castrum's *Cardo*. In particular, the oblique line of the latter might be explained if, as Becatti suggests, both had their origin in common from a primitive track or path which started from the river mouth and ran south-east across the *Piana Bella*, being directed into the *ager Laurens* down the coast. If this view is correct the site of the Castrum overlapped the junction of these two ancient trackways. Naturally air photography can not reveal traces of them within the area covered by the town.<sup>1</sup> But an exactly vertical view, e.g. Plate 58, is able to show usefully and impartially the precise angles made by the streets concerned. The identical angles which the arms of the 'Y' make with the stem must, surely, show that their lines represent a piece of professional orientation, in their present state;—this does not, of course, exclude the possibility that they regularised earlier tracks to the beach and to the mouth. Datable buildings along the south arm of the 'Y' prove that it ran on this straight line as early as the first half of the 2nd century B.C.

Ostia first acquired some importance as a naval base in the war against Hannibal and Carthage, and from the end of the 3rd century B.C. developed increasingly as a centre for civil trade. As the purchasing power and population of Rome grew so also did Ostia, importing corn and timber besides marble and many general commodities as time went on. It is not surprising that the fast-growing commercial town of late Republican times exhibited some idiosyncracies in the shape of its walled enceinte built c. 80 B.C. Practical requirements were put before formal symmetry. Its area was already as large as Pompeii.

We know from classical sources that by the Augustan period silting-up had become a serious problem for this river-mouth<sup>2</sup> port, narrow and difficult to enter. Large ships had to be unloaded off-shore into lighters.<sup>3</sup> The construction of another harbour which would be free of sand was growing urgent, and very shortly this rival appeared and flourished as we shall see.

The plan of a large thriving town like Ostia, very individualistic from its

<sup>1</sup> Further air photographs of the 'Piana Bella', on which buried roads have been found already (Fig. 23), might help with the problem.

<sup>2</sup> The Fiumicino has a river-mouth port still in action only 3 miles to the north-west, a modern analogy on a small scale. At its quayside in 1953 there lay a fine Roman sailing ship,—a full-size replica made for an historical film.

<sup>3</sup> This was in addition to the ordinary transshipment of bulk goods at Ostia from sea-going to smaller craft, which passed upstream to Rome. Cp. J. Le Gall, *Le Tibre dans l'Antiquité*, 1953, 68-72. Strabo, V, 3, 5.



long history and unique rôle, naturally could not be wholly 'put through the mill' of a tidy Augustan standardisation (contrast for example a *colonia* like Verona; Plate 62). But in early Imperial times and well into the 2nd century A.D. there was a peak of prosperity and building, both of public buildings<sup>1</sup> and large tall apartment blocks for the prosperous trading middle-class.<sup>2</sup> The town spread far beyond the obsolete Republican walls, and it is the Ostia of this phase that is chiefly to be seen on Plate 58. It was becoming as much a Bath as a Bristol.

We can gather some topographical clues from an agreeable account by Minucius Felix, soon after 200 A.D., of his holiday jaunt with two friends from Rome to the sea baths, when the law courts were closed at the vintage season. They enjoyed 'a pleasant walk, a pleasant talk, along the briny beach', strolling on the sands, before seating themselves on the stones of one of the small breakwaters that protected some baths. The baths were very likely those which have been excavated on the old shoreline at the extreme end of the Decumanus Maximus (Plate 58, top left).<sup>3</sup> Little of this sea-front has been cleared, and its systematic excavation would help greatly with the human geography of Ostia.

As the 3rd century continued an air of decay grew evident as the newer port prospered more, and in the 4th century the population of Ostia was falling and the social character of the town had greatly changed. The middle classes had followed trade and had been drawn off to the rival *Portus Romae*, and the gulf between the very rich and the very poor increased. But elegant houses were still going up in the town, and, outside, a whole chain of private mansions extended southward down the coast for at least 2 miles. They are marked by broad, irregular mounds of building débris, some under grass and others partly levelled by cultivation. These mounds appear very well in relief through the stereoscope, and their positions and exact dimensions can be mapped quickly and accurately from vertical photographs.

We need not linger over the last stages of Ostia's slow decline into waste land,—the end came 'not with a bang but a whimper'. It was vulnerable in every way. Rome's decay by land, piracy and the drying-up of trade by sea, only made final a process which the limited navigability of the Fiumara began centuries before. Without Rome, it could support itself neither as a port, sea-resort nor even as a *castrum*. Nearby, in the 9th century, a small fortress of c. 5½ acres was optimistically founded as 'Gregoriopolis' to protect the coast against the Arab raids, but soon perished. And then even the sea itself deserted the site.

<sup>1</sup> Most of the regular, massive architectural units north of the Decumanus Maximus belong to this period.

<sup>2</sup> E.g., the ambitiously planned 'Houses of the Gardens' built c. 128, two big blocks of private 'flats' with ornamental ground between and round them. It can be seen from Plate 58 how cleverly this unit of planning was fitted to the awkwardly-shaped space between the twin roads of the 'Y' fork.

<sup>3</sup> For details of their promenade from the river to the sea, cp. Le Gall, *op. cit.*, 334-7. But there are disputed readings of this text.



(ii) *The Piana Bella and ancient coast*

Air archaeology has recently made a useful contribution to the study of the important area outside the town, to the south-east. Immediately beyond the Autostrada and railway from Rome to the coast there is a large rectangular zone of level ground measuring about  $2,500 \times 1,500$  metres. This is known today as the Piana Bella (see Fig. 23) and consists of large unfenced fields under the plough.

The key feature in this area is a series of Roman roads which subdivides it. Traces of 5 parallel roads have been located, lying on a north-south axis,—and another crossing them. The combined study of British war-time air photos and of ground indications by Mr. Russell Meiggs and myself has succeeded in identifying several of these for the first time and in mapping additions to others.<sup>1</sup> On the air photographs (Fig. 23) buried roads have been discovered by means of the differential soil-, crop-, and weed-markings above them. On the ground, these indications can be clearly seen and confirmed at suitable seasons. Close to the town their lines were flanked by tombs, now levelled; and here the accumulated débris has transformed each one into a broad ridge of soil with profiles which are obvious enough (see Plate 61). Excavation has produced the *selce* of road-surfaces at one or two points. But further from the town these parallel ridges diminish and then cease; from there onwards we have to rely chiefly on the use of air photos to trace the continued course of the roads.

It is of some interest that short sectors of these buried roads were in fact visible on an air view taken from a balloon as long ago as 1911 (Calza, *Scavi di Ostia*, i, fig. 15). They then appeared as light-toned lines across the ground, just as they do in the modern photographs. Although some portions of them are marked on one of Calza's maps (fig. 36), no detailed comment seems to have been published. These lines were caused by typical 'parch-marks' in the grass, and they naturally re-appear in the same form each summer if crops or grass cover the area. The nature of parch-markings above ancient road-surfacing has been fully described above (p. 19).

These five parallel roads were field roads, not urban streets. But at least one of them was tied to a feature in the town plan,—a continuation of the street that formed the *Cardo Maximus*. Perhaps it is for reasons of this kind that the intervals between them are not uniform but vary from *c.* 500 to over 750 feet,—as near as can be calculated without excavation. In one case, the interval of *c.* 700 feet corresponds to 6 *actus*. These roads ran straight, and formed a practical *ad hoc* way of breaking-up this area of level ground. With further air photographs, and with excavation, it should be possible to discover the basis on which this irregular *limitatio* was founded. Its remains cannot be termed centuriation. The longest of these roads to be traced from the air is that which joins the line of the

<sup>1</sup> I do not wish to go into much detail here; but a reference must be made to the existence of a complex pattern of crop-markings surrounding the modern farm near the centre of the Piana Bella.



*Cardo Maximus*, at an oblique angle, at the point where the Autostrada and railway cut that line. This road then runs north-south, and after about 1,200 yards it bends to the south-west for 200 yards and reaches the sites of the Roman villas along the old coast.

In addition to these five roads, a sixth road crosses them at right angles and its buried course can be traced across the Piana Bella for at least 1,100 yards. When ground-checking these air photo sites in September 1953 I was able to measure the grass-markings above several of these buried roads; these markings, indicated a width of *c.* 10 feet, with ditches each side (probably about 4 feet wide).

All these roads need not be of the same date. There is the possibility that some may have an early origin. Little is definitely known of a *limitatio* of the land round the early town. We do know, however, that much later (under Vespasian, Trajan and Hadrian) some of the *ager Ostiensis* was divided in strips and oblongs: '*in praecisuris, in lacineis et per strigas . . . colonis eorum adsignatus*'.<sup>1</sup>

Aided by the precise locations which the air photographs have provided, it should be possible to discover much more about the chronology of this system of roads by selective excavation, at a number of points chosen in advance. Test trenches across these buried roads would be a simple matter,—but would give important results. The layout is of interest in terms of Roman cultivation,—and also in a more general way because the environs of a classical town, which helped to support it, usually receive little notice as compared with its nucleus.

This rectangle of level ground, stretching like a pendant from Roman Ostia's outskirts must have formed an important part of the cultivated ground belonging to the *castrum* and the early town. From the air (Plates 57-9) one can see how marked is the contrast between its smooth well-drained surface and (a) the lines of later dunes and (b) the marshy ground inland, reclaimed by dykes from the 'Stagno'. Its well-marked boundaries and different appearance do not result only from long Roman cultivation on this part of the *ager Ostiensis*, but proceed from the underlying fact that this area completed the 'island' of firm Pleistocene sub-soil on which Ostia grew up. The chief point that I wish to make, here, is the clear way in which the air photographs make evident this important fact of surface geology, distinguishing and demarcating this part of the *ager Ostiensis*.

In Roman times the western side of this rectangle of level ground was washed by the sea; under the Republic the oxen would have ploughed their steady furrows up to the edge of a long straight beach of firm sand, where coastal villas rose in ostentatious parade under the Empire, and where the lines of sand-dunes begin today. Its eastern edge, now marked by the Canale delle Acque Medie (a line of falling ground obvious to the observer on foot), was sharply defined by a *lacus*, an extensive inland mere (the great 'Stagno' shown on maps from the 16th century onwards). Its southern limit was the natural

<sup>1</sup> See Pais, *Storia della Colonizzazione di Roma Antica*, 62, 242, on this entry in the *liber coloniarum*; and H. F. Pelham, *Essays on Roman History*, 290.



outlet-channel<sup>1</sup> from the *lacus* to the sea, now the Canale dello Stagno; this line was regarded in classical times as the boundary between Ostia's land and that of the *Laurentes* further down the coast. Presumably, this rectangle formed part of that portion of the *ager Laurens* which we know was transferred to provide for Ostia.

The next matter to be dealt with is the ancient course of the river. The history of the Tiber at Ostia illustrates very well the now-established fact that meanders tend to move successively *down stream*; compare Fig. 24 and p. 259.

Looking at the ordinary map one would be puzzled to decide why the river has always made the sharp bend to the south, before passing Ostia and finding an outlet in the sea. But, on looking at the physical appearance of the ground (in the comprehensive air view) and studying the texture of its surface (which only special soil-maps would try to show), it becomes clear that the sharp bend was caused by the presence of the Isola Sacra as an 'island' of firmer Pleistocene sub-soil, which obstructed the path of the Tiber as it forced its way out to the sea after wandering through the marshy plain behind. This geological 'island' has, in fact, been cut into (and perhaps cut through) on its inland side by the Tiber's course. An important point, therefore, to keep in mind is that the formation of a meander is positively encouraged in the area east of a line drawn from *Portus* to Ostia, because of the relative obstacle of the belt of firm ground of Pleistocene formation along that line. This point has not been made clear previously.

We can quickly summarise the accepted history of this sector of the river. Just over a mile upstream from Roman Ostia the Tiber divides into two channels, at the place now called Capo-Due-Rami, enclosing the Isola Sacra. The northern one, 'Fiumicino', was of Roman construction and is described below (p. 249). The southern one, 'Fiumara', is the only natural channel and its bed formerly occupied a long meander-loop<sup>2</sup> (Fig. 23) whose apex reached to the medieval and modern village of Ostia; by the 13th century it had eroded its way through the Via Ostiensis on the vulnerable bank on the outer curve. The part of this loop adjacent to the Roman town can be seen on Plate 58 (p. 239, n. 2). But *c.* September 1557 the bend moved down-stream,—when the river in flood took its present course, cutting through the base of the earlier loop which became a typical 'Fiume Morto' and gradually dry (Plate 61; parts were being filled-in as late as 1860). Today it can easily be seen how, if the solid ruins of the town made less of an obstruction, the Tiber would continue to bite further into the left bank's curve, again to move its bend down-stream.

Plate 59 also shows another piece of evidence that is probably connected with the great flood of 1557. On the right (north) bank of the main stream, the river when in flood has clearly swept its way through the sand-dunes, at the point where these approach the islands now in the channel. The signs of erosion

<sup>1</sup> On the other side of this channel, southwards again and stretching from Castel Fusano, lay another long narrow 'island' in the Pleistocene chain.

<sup>2</sup> The *fluminis flexus* of Ovid, *Fastes*, IV, 329.



are still very clear in the soil of the fields. From the position of coastal fortifications during the campaigns of the mid-16th century,<sup>1</sup> we can see that the coast-line and river-mouth had already advanced westwards to just about the point where these signs of a devastating flood cease. The islands and the formation of the braided channel are also probably a consequence of the same event.

From the consideration of the ancient Tiber we logically come next to the coast. Its advancing line raises some of the most interesting questions in Ostia's topography, and the structure and development of the delta are more graphically seen from the air (Plate 57) than even on maps of large scale, say 1 : 25,000.<sup>2</sup> Among the major factors involved are of course the quantity and rate of silt brought down by the river, and the action of the shore current which sweeps the coast from south to north. The deflection of the silt more to the north side of the mouth accounts for the greater extension of the land on that side, and is well demonstrated on the air photographs by the shape of the stream of yellow, muddy water ejected from the mouth and out to sea.

That the majority of the advance is comparatively recent, historically, is certain; the main interest lies in what happened in Roman times. Useful attempts have been made to map the stages of the advance, by indicating the general position of successive coast-lines at approximate dates,<sup>3</sup> building up to the present apex at the mouth. This works well for the later stages, but by the time we arrive back in the Republican period the process is abandoned and we are left with an almost straight coast-line as a *fait accompli*, without antecedents and 'no visible means of support'. A reader might well ask how it came to be there, and how matters arranged themselves before. The difficulty has arisen through the failure to show, at least in archaeological accounts, the significance of the chain of 'islands' of Pleistocene foundation from *Portus* to Castel Fusano, and their fundamental difference from the dunes in front of them and the zone of alluvial silt inland. Only by giving full weight to this fact can we understand the nature of the relatively stabilised coast during (and for some period before) the Roman occupation of Ostia. This line was not a mere stage in the series of slowly advancing dunes.<sup>4</sup> Geologically it was a fixed line

<sup>1</sup> Cp. Le Gall, *op. cit.*

<sup>2</sup> See Marinelli, *Atlante dei Tipi Geografici* (Istituto Geografico Militare, Firenze), 2nd ed., 1948 (2 vols., text and maps), Tav. 53. In this useful atlas, it is also interesting to compare the exactly similar siting of ancient Ostia and ancient Volturmo (now occupied by Castelvolturmo near the mouth of the Volturmo river). The latter's position at the bend of the river and the later triangular delta built up in front of it (in the Middle Ages and later) could easily be mistaken for Ostia and the Fiumara. The air photograph of the Volturmo delta (Tav. 53, 3) should be compared with our Plate 57).

<sup>3</sup> E.g. Paschetto, *Ostia Colonia Romana*, 1912, Fig. 1, and Tav. III at end; Lugli and Filibeck, *Il Porto di Roma Imperiale e L'Agro Portuense*, 1935, Map 1.

<sup>4</sup> Even Calza in his masterly account (*Scavi di Ostia*, i, 63) fails to make this point clear. He writes 'Il terreno su cui Ostia sorse è il terreno sabbioso del litorale che dobbiamo supporre fosse anche allora, com'è oggi, cosparso di duni naturali prodotti delle sabbie sotto l'azione dei venti. E esso dovette quindi essere reso pianeggiante in modo da ridurre ad un eguale unico livello la città che ci vi fondò sopra nella quale non si riscontrano infatti né ondulazioni né pendii sensibili'. If we accepted this view we are left with a picture of undifferentiated sand; hence the difficulties of interpretation that have arisen.



inherited from an earlier epoch; it was not the product of gradually advancing dunes. The Republican settlement was founded on a firm shore-line.

The plain and essential fact is that in Roman times the coast only advanced very slowly from this line. Even the estimate of 2 feet per annum (70 yards in 100 years) in the early Imperial period (Calza, *op. cit.*, 63) probably exaggerates the growth, as we can now see from the Chronological Index of dated buildings at the end of the first volume of *Scavi di Ostia*. For example, the tomb of Cartilius Poplicola,<sup>1</sup> which Professor Calza dates as 25 B.C., stands about 75 yards outside the Porta Marina and only 100 yards from the agreed position of the late Roman coastline (as evidenced by the situation of the coastal baths of 4th century construction),<sup>2</sup> along the west side of the road to Fiumicino. Then again, the town wall (c. 80 B.C.), of the period of Sulla, comes within 90 yards (or less) of the accepted coastline of late Roman times. Both these examples, and others that could be mentioned, come from points 300-600 yards from the river's mouth at that time.

The slow rate of coastal advance in Roman times may perhaps be best explained by the supposition that the Tiber's silt was largely engaged in filling up the marshes on either side behind Ostia.

The course of the coast line in Imperial times (Fig. 23) is given by several fixed points; for example by (i) the line (A) of the coastal 'villa' mounds, (ii) buildings at the sea end of the Decumanus Maximus, (iii) the area (B) of the Torre Bovacciana, and (iv) the Roman road (C-D) that linked Ostia and Portus along the front of the Isola Sacra.<sup>3</sup>

Of course, even in the Roman period the amount of silt brought down to the mouth by the Tiber was noteworthy;<sup>4</sup> yet in immediately post-Roman times the advance of the delta seems to have remained slow. The rate of advance can roughly be shown as a graph, using abandoned coastal watch-towers as date-points for successive shore lines. Le Gall (*op. cit.*, 22-7) makes it clear that it was throughout the Middle Ages and especially since the 16th century that the prodigious building-up of dunes accelerated with increasing speed. In this process the Fiumara's mouth advanced slightly faster than the Fiumicino's. The causes have been much debated. The cumulative effects of deforestation, especially for charcoal-burning, have been blamed; further, in the last century river-control has caused the channel to deepen and to bring down more silt to deposit at the mouth. True, Mascart claimed that deforestation on the Sabine hills since the mid-19th century has not had a noticeable effect on the Tiber;

<sup>1</sup> *Scavi di Ostia*, i, fig. 29; Reg. IV, Is. IX. 2; and p. 233.

<sup>2</sup> *Ibid.*, fig. 35, and p. 155.

<sup>3</sup> The Roman shoreline lay just west of this, approximately on the line of the straight modern road from Ostia to Fiumicino. For the Roman road, cp. Calza, *La Necropoli del Porto di Roma nel Isola Sacra*, 1940, Tav. II (map.); he considers that it was most probably built in the second half of the 1st century A.D., when a good road linking Ostia and the new Portus would have been necessary. A country trackway which followed roughly the same course was removed during the latest modern bonificazione.

<sup>4</sup> E.g. Vergil (*Aen.* VII, 31), *multa flavus harena in mare prorumpit*.



but probably the damage from this had already reached maximum. On angular limestone hills, the destruction of the surface humus following excessive felling of trees and scrub is usually reckoned very severe, only exceeded by the loss of soil from bared marl slopes. I have studied charcoal burners, with their great primitive kilns, at work up on the limestone massif of the Gargano in Apulia; no young bush in the natural woodland was spared in the area cleared, all was 'grist to their mill'. In such circumstances, soil erosion comes quickly.

In studying the topography and history of Ostia, Portus, and their surroundings we are compelled to pay considerable attention to later changes in the landscape, to the history of coast forts, drainage canals, roads, cultivation and land-reclamation generally in the last few centuries;—in short to the archaeology of the recent past.

In this interesting work of 'winnowing out' the ancient landscape, vertical air photographs have been helpful. Plate 59, a 'mosaic', reduced from photographs with an original scale of 1 : 13,500 taken in 1943, was most useful in disentangling the different phases of the landscape's growth. This has, of course, been undergoing particularly drastic changes in the last generation, especially on the Isola Sacra. Here, the regular modern land-partition, whose oblong units recall Roman divisions *per scamna et strigas*, already looks as though it had been well established for many lifetimes. Early in the present century a reclamation scheme was beginning to take effect, but it was not until as recently as 1925 that the 'Opera Nazionale Combattenti' planted settlers in standardised farms at intervals along the new roads and laid out the gridded fields. All this exactly repeated in modern times the methods practised 2,000 years before as shown by the Roman systems of centuriation discovered in Apulia, to which I have referred (p. 148). The resemblances of detail were often remarkable.

On the Isola Sacra, the Roman road from Ostia to Portus must have stood very close to the shore when it was built. Its course can be clearly traced on the air photographs I have examined. In post-classical times it became partially covered by dunes raised by blown sand (as, I think, may be true of part of the course of the Via Severina south of Ostia); but in 1925 the tops of the dunes were levelled off to facilitate irrigation of the new fields, and a stretch of the metalled road (2 metres below the levelled surface) was excavated. It was lined by architectural tombs, in use from the 2nd to 4th centuries A.D. (part of the cemetery for the inhabitants of Portus). My air photographs have also shown traces of a buried street of tombs (revealed by surface markings in the fields) running parallel with the Roman road, in the major part of the cemetery which lies nearer the Fiumicino channel. In spite of the modern parcelling of the ancient Isola Sacra into small fields, we can still expect some aerial discoveries, especially from crop-markings.

Plate 59 well shows the contrast between the smoothly level expanse of the part that was in Roman hands and the post-Roman dune-covered portion. It is noticeable that soil-markings of former dunes are almost completely absent



from the ancient Isola, and this fact is not due to modern cultivation, nor would post-Roman wind-blown sand have levelled-off dunes if they had covered this part. Some surface-levelling was doubtless done in classical times, but the fundamental point is that there is a difference in kind; the ancient Isola formed part of one of the patches of Pleistocene sub-soil and may have been comparatively level to start with, like the 'Piana Bella'. Very little is known of how the Isola Sacra was used while Ostia was flourishing. It would be strange if this fertile island on the doorstep of the two towns had not been put to good use in helping to feed them. Aethicus (4th century) wrote that it was noted for its rich pasture. The name 'Isola Sacra' is only recorded for the first time in Procopius, as late as the 6th century.

(iii) *The harbours of Claudius and Trajan*

The last element of the Ostian landscape that we shall examine is the pair of great artificial harbours built by Claudius and Trajan. The aerial views on Plates 57 and 60 are presented in the hope that they will assist future study, and not as solutions to the many puzzling problems for which these sites are notorious. My purpose is to explain the air photographic evidence,—no more.

On sites as large as these, vertical photographs usefully display the crucial points of topography in a comprehensive view. But the best photographs could not solve the chief questions here,—only systematic excavation could do so. Sporadic digging has been done, but many essential matters remain in a state of doubt. It is not that further excavation would be difficult technically, for there are many topographical clues to follow,—the need is for concentration on a few vital points. One cannot escape the fact that no amount of intensive reasoning or reading of past studies can at present resolve some of the problems: the requisite data are still insufficient. It is well to begin with that conclusion.

If there is still much that we need to know about Trajan's inner port, knowledge of the buildings of the outer Claudian harbour can hardly be said to be more than whets the appetite. Yet this latter harbour—though outwardly only earth-works remain—can justly be considered one of the most interesting sites in the whole range of Roman field-archaeology, and certainly one that deserves further attention. It was not for nothing that these harbours, though at first subsidiary to Ostia, became indispensable to the imperial capital and bore the proud name of 'Portus Romae'. Spasmodic antiquarian interest in their sites goes back for centuries, but much of what has been written is difficult to consult.<sup>1</sup>

<sup>1</sup> The only definitive and modern account is by Prof. G. Lugli and G. Filibeck, *Il Porto di Roma Imperiale e l'Agro Portuense*, Rome, 1935. The former deals with the archaeology of the harbours and his trial-trenches on the Claudian moles, the latter describes recent land-reclamation. It is unfortunate that a book of such importance was printed in a restricted edition. I have not found it in any library in Oxford or London (even at the British Museum), but there is a copy in the British School at Rome. Among earlier works mention should be made of those by A. Nibby, *Della Via Portuense e l'antica città di Porto*, 1827, and *Analisi della Carta de' dintorni di Roma*, 1837, vol. ii, 'Porto', 602-59; cp. also R. Lanciani, in *Annali dell' Istituto di Correspondenza Archeologica*, 1868, 144-195; and G. Calza in *Notizie degli Scavi*, 1925, 54 seq. Lugli's plan of the harbours, showing his excavations in 1934, can also be found in *Atti della Pontificia Accademia Romana di Archeologia*, 1947-9, 187 seq.



In the following pages I propose to concentrate chiefly on the study of the remains of the Claudian harbour, to which air survey is particularly applicable.

According to Plutarch it was Caesar who first had it in mind to build an artificial harbour free of Ostia's disadvantages, but death prevented the design. During the whole of the Republic the banks at the entrance to the river-mouth had formed a port for Rome,—not without increasing difficulties, involving transshipment. The effects and causes were evident, and it was naturally concluded that by abandoning the Tiber the dangers from deposit would be avoided and that the new port would be effectually removed from alluvial silting. By placing the entrance on the north-east side it would be better protected against the winds prevailing from the south and west.

Although the Claudian port was an impressive piece of engineering it was too near the mouth of the Tiber to be effective, and perhaps it interfered with the free action of the south to north current along the shore and even may have made matters worse. It was only by experience that the error was discovered. Not many centuries passed before this port became filled up by the alluvial matter brought in by the littoral currents. The alluvium which is held in suspension when carried along by the river is naturally deposited at the mouth, and, as the shore current is not strong enough to carry it away there is an inherent tendency to form sand-bars (p. 254) producing successive advancement of the low-water mark. In short, shipping facilities at Tiber's mouth are inherently limited and disadvantageous,—witness the humble village quay at Fiumicino today, no 'Port of London'!

When, at the beginning of the Empire, Rome with its suburbs may have had a population approaching one million, something better than the primitive natural facilities of the river-bend at Ostia was needed. Claudius, fond of big schemes (e.g. the long *emissarium* from the Lago di Fucino) stepped in and began work in 42 A.D. The grandiose project was still in progress at his death in 54 and it was not completed until shortly after by Nero.<sup>1</sup> The immediate incentive was to remedy famines in Rome by creating a convenient unloading point where grain could be temporarily stored. But the port naturally handled cargo vessels with goods for the capital from all parts of the Mediterranean.

There is a well-known inscription, found in 1836 in the Portus area and dated c. 46 A.D., which speaks of waterways (*fossae*) which were dug by Claudius from the Tiber to the sea in connection with the building of his port.<sup>2</sup> As far as can be established Claudius anticipated Trajan's famous Fossa, in making a new mouth for the Tiber. Claudius's *fossae* have not been definitely located,—most probably they were partly re-used (and possibly partly filled-in) by Trajan.

<sup>1</sup> Prof. Lugli thinks that part of its left mole was in ruins even before Trajan's port was built; he argues that only thus can we explain the need to create a new port 50 years after the earlier one. Proof from further excavation will be required before this theory can be accepted.

<sup>2</sup> C.I.L., XIV, no. 85: *fossis ductis a Tiberi operis portus caussa emissisque in mare urbem inundationis periculo liberavit.*



Lugli has re-examined the possibilities,<sup>1</sup> but without conclusive results. The air photos studied by me do not throw further light on the matter: any major buried canal in the fields between Trajan's port and the Tiber round Capo Due Rami would certainly have been visible on the photographs as a characteristic 'soil-mark'. The line of the Via Portuense which crosses this area can be very clearly seen in this way.

It might be hoped that the plans of the harbours by early antiquarians and cartographers from observations made before the tidying of the landscape in recent generations, would give us some help with these problems. For the environs and buildings of the port of Trajan such records have a certain value. But the tendency was to the copying of theoretical compilations; to the archaeology of the Claudian harbour, which could only be studied effectively in the field, they contribute little.<sup>2</sup>

Looking at the interior of the Claudian harbour one sees today a level, slightly-sunken expanse of fields with a broad earthen bank on the east side, another bank which gradually diminishes on the north, and a wide gap at the north-east corner<sup>3</sup>. How far can we correlate this layout with the indications given by classical writers? Today, it is agreed that they correspond to the right mole, left mole, and entrance, to which the sources refer.

It is undeniable that the references by classical historians to the construction of the Claudian port are disappointingly few, brief and generalised; and even the occasional details are far from easy to interpret. The most explicit are those in Pliny, Suetonius and Dio. Of these only Pliny wrote as a contemporary. Suetonius gives the most coherent and informative account (cf. *Claud.* XX, 3), published c. 120 A.D. Let us see what he tells, before comparing the evidence in the field. Describing the public works initiated by Claudius he first mentions the construction of an outlet 3 miles long from the Lago di Fucino on which 30,000 men worked for eleven years. This gives some picture of the scale of effort that we may imagine in connection with the new port. 'He created the harbour at Ostia by building curving breakwaters on the right and on the left; at the entrance a mole was constructed in deep water, and to establish it more securely he first sank the ship in which the great obelisk<sup>4</sup> from Egypt had been carried; reinforcing it with piles he placed on the top a very high tower on the principle of the Pharos at Alexandria, so that its beacon light at night would direct the course of ships'.<sup>5</sup>

<sup>1</sup> Lugli and Filibeck, *op. cit.*, 29, 66.

<sup>2</sup> Lugli, 'Una pianta inedita del Porto Ostiense disegnata da Pirro Ligorio e l'iconografia della città di Porto nel secolo XVI', in *Atti della Pontificia Accademia Romana di Archeologia*, 23-4, 1947-9, pp. 187-207. Among various plans it includes reproductions of Du Pérac's (1575) and Texier's (1858).

<sup>3</sup> The Italian 1 : 100,000 map (sh. 149) dated 1888 shows the whole interior of the Claudian port as marsh. Cp. *Grande Atlante dei Tipi Geografici*, tav. 53A.

<sup>4</sup> I.e. the obelisk which now stands before St. Peter's in Rome.

<sup>5</sup> *Portum Ostiae exstruxit circumducto dextra sinistraque brachio et ad introitum profundo iam solo mole obiecta; quam quo stabilis fundaret, navem ante demersit, qua magnus obeliscus ex Aegypto fuerat advectus, congestisque pilis superposuit altissimam turrem in exemplum Alexandrini Phari, ut ad nocturnos ignes cursum navigia dirigerent.*



Dio's account<sup>1</sup> contains some additional particulars, but the exact sense is difficult of translation. In brief, he relates that the engineers attempted to dissuade Claudius because of the cost. However he excavated a large tract of land, and after completion he let the sea enter it; then in the sea he built moles on both sides of the entrance,—thus enclosing a large area of water,—and set up an island on which he placed a tower with a beacon. Pliny's references<sup>2</sup> do not take us much farther. When describing the marvels of giant trees and obelisks brought by sea to Rome he alludes to the ship that was sunk as a caisson: 'in length it occupied a large part of the left side of the harbour';<sup>3</sup> he adds that three substantial piles made of Pozzuoli cement were built upon it before it was scuttled.

To supplement these accounts there is the famous view of the 'Portus Ostiensis Augusti' on a coin of Nero's, showing (left) a mole with porticos and (right) a mole with arched construction, with a lighthouse surmounted by a figure between them. The representation on the Peutinger Map adds little to this. The lighthouse inspired many Roman artists, and the symbol of a lighthouse was used in Christian iconography to signify divine protection. Professor Lugli instances a votive relief in the Museo Torlonia which shows a tower with five storeys with flames emerging from the uppermost one and an imperial figure on the penultimate; he also cites a sarcophagus in the Museo Lateranense showing a five-storied tower, and others in mosaics and reliefs which have four storeys with a door at ground level and windows on the upper floors. The *pharos* motif was often pictured at Ostia.<sup>4</sup> It seems that the ruins of the lighthouse were still visible in the 15th century according to that pioneer antiquary Flavio Biondo: and Sixtus IV, who visited Portus when he was at Ostia in 1483, also mentioned that he saw 'the walls of Portus, though much destroyed, and the tower of Pharos'.

Continuing since that time, the destruction of buildings above ground has been complete. The evidence is now locked up in the soil. But, after the copious discussions which have revolved around the meagre descriptions in the early sources, it is with feelings of relief that one turns to the extant remains in the field, however depleted they are.

It happened that at the time when the photo on Pl. 60 was taken (March 1944) the local conditions were, in a special way, more helpful to archaeology than is possible normally; indeed conditions were extraordinarily suitable for revealing the ancient topography. The German forces had caused this coastal area to be flooded for defensive reasons, and the fields inside the harbour were

<sup>1</sup> Dio Cassius, *Roman History*, Bk. LX, ch. 11 (written c. 200-22 A.D.).

<sup>2</sup> Pliny (A.D. 23-79), *Nat. Hist.*, Bk. XVI, 76; XXXVI, 14.

<sup>3</sup> The apparent conflict between this vague phrase of Pliny's and Dio's account can only be settled by excavation.

<sup>4</sup> Calza, *La Necropoli del Porto di Roma nell' Isola Sacra*, 1940, fig. 83, fig. 107, and p. 186, n. 8. Calza's volume also contains (fig. 5) a photograph of a model which attempts a reconstruction of the appearance of the ports when in use.



covered by shallow water to the depth of a foot or two, while those east and south of it were also sodden and water-logged. As a result, the ancient demarcation between water and land re-appeared, defining the outline of the harbour-works in a unique manner. For comparative purposes I examined a large number of photographs taken before, and at the time of, this artificial flooding.

Let us consider the chief topographical features in order, and first the right mole. The broad ridge now called Monte Giulio, which represents its course, is at least 15 feet in height, and measures 130-230 yards across,—being much spread by ploughing. It extends for *c.* 900 yards, curving gently. In his valuable report Professor Lugli mentions that he excavated some remains of a series of pillars (? a portico). On Plate 60 the shallow flooding has displayed in the best possible manner the curve of this ridge containing the right mole. The original construction of its foundations must have required a prodigious effort of soil-dumping, to which the material from the excavated area mentioned by Dio must have contributed largely. Extra width was needed for the buildings which this mole had to carry and to give space for handling un-shipped goods,—rather than for protection against the danger of erosion. The only structural feature that emerges in the air view is the alignment of the inner face of the buried retaining wall.

At the end of this ridge of soil there is a gap separating it from the next artificial hillock called 'Monte Arena' which stands to a height of 20 feet. The interval between the sloping ends of these two earth-works measures about 100 yards, but Carcopino who dug some trenches in 1907 stated that the effective distance between substructures was 120 metres. In this gap he found no traces of buildings and the evidence is indicative of its origin as a harbour entrance. The Fronzino drainage canal (built *c.* 1824) passes through, running diagonally across the harbour. A modern road has shaved off part of the side of Monte Arena,<sup>1</sup> 'Sand Hill', which is roughly square. Nibby claimed that this was the site of the Pharos; most archaeologists now agree. In his day squared blocks of tufa were visible on the top. Both Professor Carcopino and Professor Lugli have dug some trial trenches,<sup>2</sup> but sustained excavation has never been carried out. Air photos which I have examined show markings suggestive of a buried structure on the summit. Nibby also referred (II, 639) to an earthwork which projected northwards from Monte Arena and was shown on Canina's map of 1829,<sup>3</sup> but in the third edition of his work Canina removed this feature from his map.

On the ground, today, there is no discontinuity between the earth-work of Monte Arena and the continuation which forms the left mole (Plate 60).

<sup>1</sup> Some soil from the tail of the mound may have been cut away when the Canale Fronzino was built, but not enough to cause the gap itself. Nibby visited the site soon after and would surely have known if any big change had taken place.

<sup>2</sup> Carcopino found 'una grande pigna di marmo, forse spettante all' asta che impugnava il colosso d'Augusto'.

<sup>3</sup> Reproduced by Calza, *Scavi d Ostia*, I, 1953, 50.



Professor Lugli's excavations confirmed this fact. It would seem therefore that a gap between them, which must have existed if the Pharos 'island' were truly isolated originally, was filled later.

True, there is a significant distinction. The left mole, which must have stood in open water, is appropriately represented by a much lower and narrower bank than the right mole which was connected to dry land. The structural remains of the left mole, continuing westwards, were located at several points by Professor Lugli. At one point it is interrupted for a distance of 160 feet; a drainage ditch of recent times which passes through this gap may be responsible for this. About 540 yards west of the west side of Monte Arena the earth-work containing the left mole turns slightly, but definitely, to the south, and ends suddenly. At this point it is still substantial, standing *c.* 9 feet above the level of the fields outside it, as is shown by the ground photograph on Plate 61,<sup>1</sup> taken in 1953-54 when ground-checking the air photos.

The main runway of a large new airport was being constructed to the north close to this spot, and threatened to endanger the earth-works of the Claudian port.

The farther we go from the Roman coast the more we get into deep water, metaphorically and archaeologically. What has become of the continuation of the left mole which completed the enclosure of the harbour in the open sea?

To investigate this problem we must turn again to the air photographic data. On Plate 60 we see a long straight line, running north to south, at the western end of the harbour. On one side, in the interior of the harbour, the ground is slightly lower and appears almost black on the photograph because it was under flood water. Westward, where the ground level is relatively a little higher and escaped the flooding, we see a series of parallel 'sand-bars',<sup>2</sup> which have accumulated during the gradual withdrawal of the coast in post-Roman times. This north-south line, has so far been un-rewarding archaeologically. On the ground there is a fall of 3 feet to the level of the harbour, and the line could be explained as that of a natural sand-dune: no traces of a mole were found by Lugli's test trenches<sup>3</sup> on this line. Furthermore, the present end of the left mole lies some distance to the west of this line, and its final portion is inclined to the south. Judging from this, the southward continuation of the left mole could have passed close to the modern farm adjacent to the railway line. Facing the sea in this position it would have been very vulnerable to destruction and submersion. We do not know, as yet, how the left mole was connected with the line of the coast further south, or even if there was originally an entrance of some kind, or if some gap developed.<sup>4</sup> We must keep an open mind on the possibilities. It is a very long way (*c.* 1,200 yards) from the present end of the left mole

<sup>1</sup> Compare the air photo of 1907 reproduced by Lugli, *Atti del V Congresso Nazionale di Studi Romani*, vol. ii, 1940, tav. XLI.

<sup>2</sup> It is desirable to explain my use of this term: in the following pages it refers to broad low ridges of sand,—as the result of modern ploughing most of them have been levelled to the height of one foot or so.

<sup>3</sup> Marked 'b, c, d' on Lugli's plan.

<sup>4</sup> There is an interesting passage in Ammianus Marcellinus (xix, 10), from the later days of Portus,



before we reach the nearest point of dry land to the south; i.e. the position of the Claudian portico which stood on the beach, at the base of the long thin mole (No. 7 on Lugli's plan) at the south-west corner of the harbour. This mole was attached to dry land and projected northwards into the harbour, protecting the quays and oblong basin (the 'Darsena') to the east partly Claudian and partly Trajanic. Lugli observes that it seems to be of the late Empire, on an earlier foundation. Immediately outside this mole there is now an area of modern bonificazione, in squares, so intensively levelled that we do not have even the remains of the sand-bars to help us.

The aerial view on Plate 60 does, however, make one fact very clear. I refer to the building-up of the parallel sand-bars or dunes against the fixed obstacles of the north side and north-west corner of the Claudian harbour. The demonstration of this fact<sup>1</sup> is potentially very useful in the consideration of the archaeological problems. At ground-level (see Plate 61) the parallel lines have so little height today that one would not appreciate their layout or their topographical importance without the benefit of the air view, which enables them to be seen as colour-differences, i.e. soil marks.

Air photographs demonstrate two aspects of the matter, (i) the curving lines of sand-bars which were swept by the retreating sea against the north side of the left mole, (ii) straight lines of rippled sand which accumulated inside the harbour on the north-south line, and lie at a different angle from these outside. Their parallel lines across the harbour are visible up to the right mole itself, i.e. over the whole interior. Were they caused by the action of the sea at an early date when the harbour was full of water,—perhaps consequent on a breach of the west side of the left mole? Or are these lines inside the harbour of much later date,—due to wind action and the formation of dune ridges on dry land which have been levelled by recent cultivation?

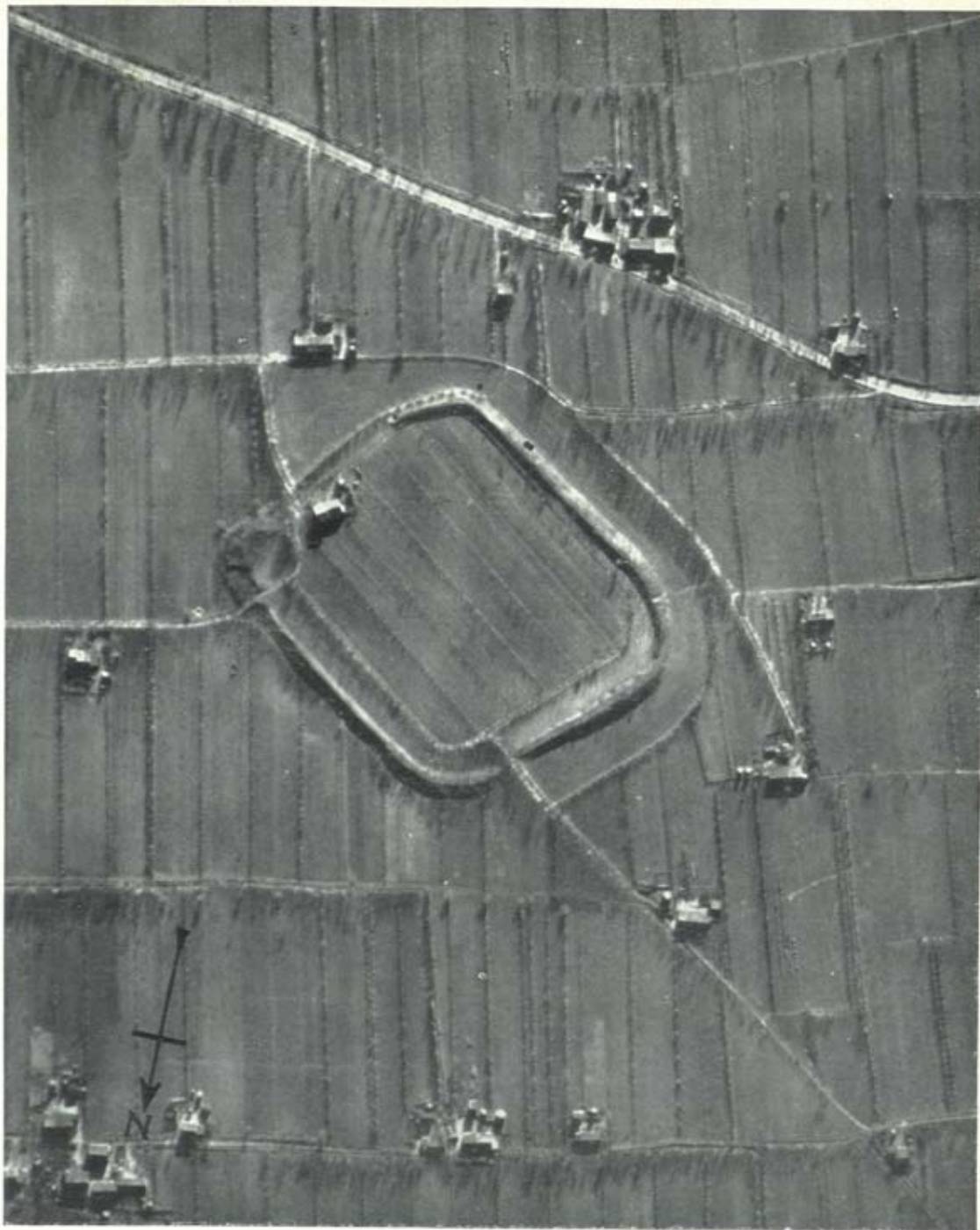
These are questions which only excavation can properly answer. So, also, is that which concerns the long, narrow, slightly sunken band of ground which comes to a sharp point at the north-west corner. On Plate 60 it is dark in tone, due to the flooding; on the ground it lies about  $2\frac{1}{2}$  feet below the level of the surrounding land. Its position must be outside the harbour, and its formation was no doubt due to natural causes. It corresponds to the feature which geographers term a 'low'. Professor J. A. Steers of the Department of Geography in the University of Cambridge, for whose advice on this and other Ostian problems of topography I am deeply indebted, has examined the photographs. A 'low', he observes, is quite a usual feature on a sandy coast, as in Norfolk.<sup>2</sup>

which throws some light on this point: 'dum Tertullus apud Ostia in aede sacrificat Castorum, tranquillitas mare molliuit, mutatoque in austrum placidum vento, velificatione plena portum naves ingressae, frumentis horrea refecerunt'. The sea's calmness changed, and the wind veering in *austrum*, i.e. the south-south-west, the fleet entered the harbour in full sail. I am grateful to Mr. Meiggs for kindly drawing my attention to this passage, seemingly indicating an entry to the port.

<sup>1</sup> This phenomenon is not paralleled at any other point at the mouth of the Tiber.

<sup>2</sup> He instances the feature called the 'Great Sand Low' in the dunes north-west of Blakeney.





66. NORTH ITALY, LE MOTTE. A rectangular earthwork of a little-known type (probably medieval), in the Veneto, near the sites shown on Plate 65. It measures about  $250 \times 200$  metres, with a large earth rampart and traces of a wide ditch. Four equidistant parallel lines of country lanes, among fields of lucerne and scattered farms, show remains of an earlier landscape of Roman centuriation.

See p. 268. Vertical photo. *Crown Copyright Reserved.*



67. LE MOTTE. (a) *above*. Profile of the inside of the west rampart.  
 (b) *below*. Profile of the outside of the north rampart. Its earthworks  
 are remarkably well-preserved. Ph. Bradford, 1952.





68. NORTH-EAST ITALY, PALMANOVA. The construction of this fortress town was begun in 1593 by Venice; the plan is the finest of its kind in Europe. The vast star-shaped defences are now of purely archaeological significance and the town is known for its lace-making. See p. 270.  
*Vertical photo. Crown Copyright Reserved.*



69. AUVERGNE, GERGOVIA. Vertical view showing the topography of this hill-top *oppidum* of Vercingetorix, the scene of a famous siege in 52 B.C. during Caesar's invasions. The long rectangular plateau outlines the area of the late Iron Age hill-fort. (E) Gallo-Roman entrance. (F) site of Roman temple. See p. 263. *Crown Copyright Reserved.*



He adds:—‘This kind of thing is very common, but it is almost impossible to give you a precise reason why it should happen in any particular case. Your problem, however, does suggest that a “low” of some kind developed here, and then, after that, wave action worked on material brought down by the Tiber and by other means and produced a series of ridges. All I would say, as far as this is concerned, is that “lows” of this sort are not at all uncommon, and you often find places where a series of ridges temporarily gives place to an area where there are none and then again follows an area where ridges have been built’.

Various attempts have been made to estimate the position of the coast line when Portus was first built. Lugli’s reconstruction for A.D. 14 shows the beach running straight north-north-west from the Tiber’s mouth at Ostia, as far as the south side of the Claudian harbour where it turned north-east and then north.<sup>1</sup> Some consider that a large part of the right mole was backed by dry land from the start, while others think that it lay almost entirely in water. Lugli’s suggested coast line corresponds with the edge of the zone of firmer ground (pleistocene sands) whose importance has been emphasised above (p. 238),—and which gave a solid base for Ostia town and a good jumping-off point for the Claudian harbour works.

Probably the Claudian harbour was somewhat unsatisfactory from the first. The wind would easily whip up this broad expanse of shallow water,—indeed Tacitus tells that in 62 A.D. some 200 merchant ships were wrecked inside the harbour, no doubt from this cause.

It is not surprising, therefore, that Trajan built an improved and safer port. Of its construction we hear little from Roman sources. A scholiast of Juvenal noted that the Emperor restored the harbour and added a better one. The date c. 107 A.D. is generally assigned to the new port, but its completion must have occupied several years. One of Trajan’s coins shows a representation of it. Little need be said here of the famous hexagonal plan; naturally it gave greater security than Claudius’s excessively large creation, being deeper and smaller, and land-locked. Harbour facilities and access were more effective; the six quay sides (each 357.7 m. long) gave ample space for berthing and unloading grain ships. Its clear-cut outline results from the extensive modern reclamation and restoration done by Prince Torlonia, on whose estate it now lies. Excavations and topographical researches described by Lanciani, Calza, Lugli and others have located and planned numerous surrounding buildings. Regrettably, access to the port is very rarely granted today.

The vicinity of the port became a true town, but because the area has been levelled, planted with trees, and ‘ripristinata’, air photographs have been of little help in locating buried buildings. Not resting content with re-founding Portus, Trajan built another harbour base near his villa at *Centumcellae*, Civitavecchia.<sup>2</sup> Although twice as far from Rome it was a better site, free from river

<sup>1</sup> Lugli and Filibeck, *op. cit.*, carta I.

<sup>2</sup> Cp. S. Bastianelli, *Centumcellae; Castrum Novum*, 1954 (Vol. XIV of *Italia Romana: Municipi e Colonie*).



deposits, on a rocky coast with clear and not muddy water. Pliny describes the initial method of construction which was by dumping blocks of stone in the sea, as we still do.

Portus did not become a *municipium* until the time of Constantine. Its history and that of the Tiber in the late Empire have been well summarised by Le Gall (*Le Tibre dans l'Antiquité*, 321). References in the late 4th century are all to Portus for maritime trade, not Ostia. In c. 409 it was attacked by Alaric; in 455 Genseric the Vandal ruler disembarked here; even during the 5th to 6th centuries it is spoken of as active by Cassiodorus. But from the 7th to 9th centuries we hear little about it except the names of a few bishops. No doubt the silting of the port and its physical decay were very marked by this time. Even the Fossa Traiana became clogged and largely overgrown by the 12th century,—to be refurbished by Paul V in 1612. Among all the dismal breakdowns of ordered life in the Dark Ages, the slow rotting of this port into a swamp must have been a great, though silent, tragedy.

#### VERONA AND THE RIVER ADIGE IN THE ROMAN PERIOD

Now let us turn from the sites of ruined cities to the living towns in which the elements of the Classical plan can be usefully demonstrated from air photographs.

Verona (Plate 62) specially deserves illustration, not only for the clearly surviving outline of the Roman city's street-plan, but also for its connection with the curious problem of the ancient course of the river. Turin's plan is more often illustrated, but there the effect of the appearance of the classical *insulae* is diminished by the surrounding grid of modern house-blocks on the same axis, which distracts the eye.

At Verona the precursor of the Roman settlement was a Rhaetian tribal centre, probably with an *oppidum* on the commanding hill of Castel San Pietro adjoining the east bank of the River Adige, on whose summit the Visconti later built their castle. It lay astride long-used routes of prehistoric trade and movement, and in Roman hands these advantages grew still more compelling; with one hand the site controlled the approaches to the Brenner Pass northward, and with the other the important west-east route that skirted the sub-Alpine foot-hills to reach the head of the Adriatic and thence to Balkan connections. Such a junction, at a good river-crossing, held the seeds of greatness. Travellers coming down the Brenner Pass and emerging into the great plain are always impressed with the strength of Verona's situation.

The archaeology of the Roman town-plan has been studied with care, notably by I. A. Richmond and W. G. Holford (from whose account<sup>1</sup> I quote) and by

It is interesting to compare his reconstructed plan of this harbour with the layout of the double port, a Portus.

<sup>1</sup> *Papers of the British School at Rome*, XIII, 1935, 69-76.



Pirro Marconi.<sup>1</sup> The original Latin colony planted by Rome early in the 1st century B.C. has left little trace, and has been 'lost to sight under an Augustan standardisation like so many early foundations in Cisalpine Gaul. . . . The Augustan town wall is not visible now but the inference that it bounded the rectangular street system can be confirmed at three points'. In its rôle of sentinel at the foot of the Alps, Verona resembles the *colonia* of Turin which was founded c. 28 B.C. Professor Richmond has suggested that the rebuilding of Verona, in the form which survives, can best be connected with the preparations for the Roman forcing of the Brenner and conquest of Rhaetia, in 15 B.C.<sup>2</sup>

Professor Fraccaro has emphasised<sup>3</sup> that the *Via Postumia*, which enters the city from the south through the Porta dei Borsari, provided the main N.E.-S.W. axis on which the orientation of the Roman plan came to be based. This strategic road, carried right across North Italy from Genoa to Aquileia, dated from the consulship of Spurius Postumius Albinus in 148 B.C. One feature which this air photograph makes clear is the alignment in parallel of the long straight street on the north bank (Plate 62) and the other main axis (N.W.-S.E.) of the grid of the Roman city. This street is the continuation of the *Via Postumia*, after its crossing of the Adige, heading eastwards towards Aquileia.

The earliest known Roman bridge to span the river still survives as the 'Ponte Pietra', and perhaps part of it may date from as early as the period of the Republican colony. Probably it occupied the position of an even earlier crossing, at the narrow apex of the river bend. This bridge lay off-line from the chief axial street (*Decumanus Maximus*) of the gridded plan. The main Roman bridge in Imperial times was placed a short distance downstream, at the end of this street. It is known as the 'Ponte Postumio', but its remains have almost entirely disappeared. The suggested dates for its final collapse are conflicting.

Plate 62, and also the following photos in the same series, show a very interesting feature:—a small white mark in the middle of the shrunken river-channel, exactly on the site of the Ponte Postumio. This white spot may indicate the remains of one of the piles of the Roman bridge. At the time when this photograph was taken the level of the river was abnormally low. I specially selected this aerial view from many others, because the conditions which it recorded are those which best showed the configuration of the river channel, contrasting its deep and its shallow parts. On Plate 62 the part which still contained water is the dark portion,—the white is exposed silt on the temporarily dry bed. It is important to note,—as we shall see presently when considering the original course of the river in the Roman period,—that the deep water at the bend naturally occurs on the *north* bank. Plate 62 demonstrates this fact clearly and conclusively.

<sup>1</sup> *Verona Romana*, 1938.

<sup>2</sup> Another estimated date, between c. 25 and 20 B.C., was favoured by Frothingham, *Roman Cities in N. Italy and Dalmatia*, 1910.

<sup>3</sup> 'La Via Postumia nella Venezia', in *Beiträge zur älteren europäischen Kulturgeschichte*, Band I, p. 252 (Festschrift für Rudolf Egger), Klagenfurt, 1952.

At first glance, one might expect that the topography of Roman Verona, famous for its surviving architecture,<sup>1</sup> would be straightforward. This is deceptive; in fact almost every feature bristles with problems, even the outline of

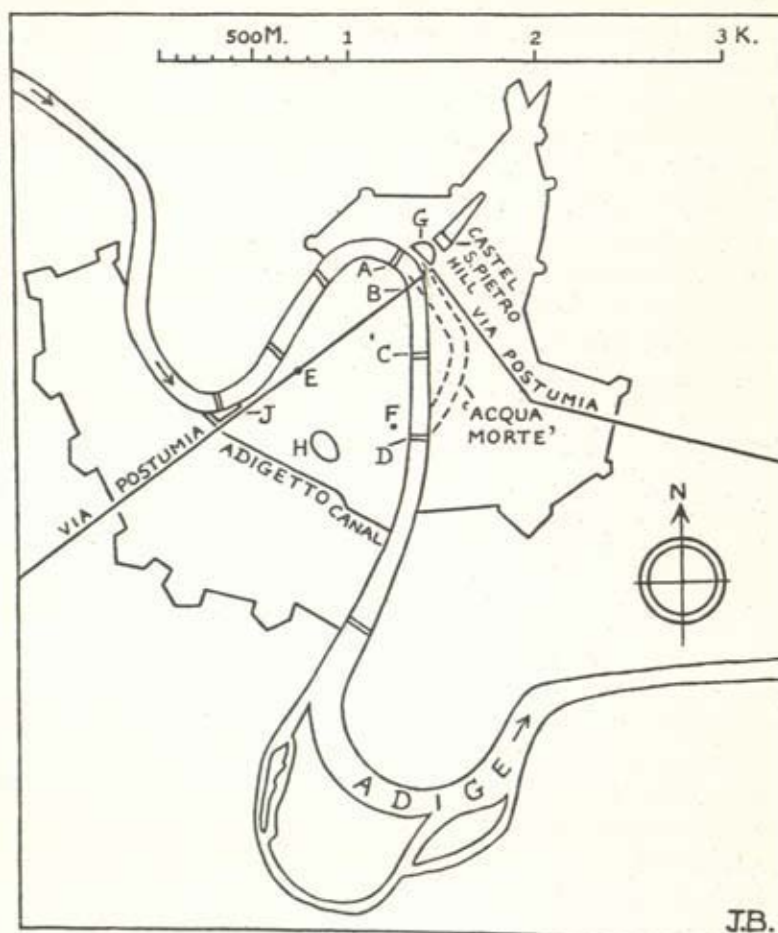


FIG. 24 Topography of Roman Verona, and the ancient channel of the river Adige: the line of the Acqua Morte (compare the old loop at the bend farther south). A Ponte 'Pietra'; B Ponte 'Postumia' (destroyed); C Ponte 'Nuovo'; D Ponte 'Delle Nave'; E Porta 'Dei Borsari'; F Porta 'Leoni'; G Theatre; H Amphitheatre; J Castel Vecchio. The medieval and later defences are shown in outline. See Plate 62 and p. 256.

the walls. Verona has all the qualifications for an ideal training-ground in the complexities of reconstructing a classical city!

This warning introduces us to one of the chief problems of the ancient plan.

<sup>1</sup> E.g. the remains of two of the Roman gates (the 'Porta dei Borsari' and 'Porta Leoni'), the Arch of the Gavii (550 m. down the Via Postumia), the amphitheatre (included within the town walls in 265 at the time of the great Gothic raids), and the theatre (between the river and the foot of the Castel S. Pietro hill).



Was its grid of streets ever completed to cover a neat rectangular area within the river bend? Richmond and Holford would conjecturally restore the original plan as a rectangle, designed to contain 8 *insulae* from north to south and 9 from west to east, 'laid out in squares 260 Roman feet broad,<sup>1</sup> indicating plots of 2 *jugera* (240 Roman feet square), bounded by 20-foot streets, except the main streets which were wider'. If so, it would have contained the same number of square *insulae* as Turin. They consider that the space for a rectangular city was in fact available (cp. plan, *op. cit.*, 73) and suggest that important later changes in the course taken by the great bend in the swiftly-running Adige have eroded away the west and east corners of the Roman street-plan, thus accounting for its rather lop-sided and incomplete appearance today. I shall confine myself, however, to the problem of the ancient river.

To support the view that the river in Roman times followed an ampler and flatter curve, it can be argued that a part of this course is still preserved today in the prominent arc of streets on the east bank opposite the city. These streets mark the line of an old channel called the 'Canale dell' Acqua Morte'; gradually they had encroached upon it until the last picturesque remnant was filled-in during 1891. Plate 62 shows the exact angle of this curve in relation to the other topographical features. It makes a good 'problem picture' to add to our 'gallery' of ancient landscapes.<sup>2</sup>

It is geomorphology, the study of land forms, that must be the first 'court of appeal'. The mechanism of meanders and their formation is known empirically; it can be observed and tested endlessly. The verdict from this seems clear:—the 'Acqua Morte' must have *preceded* the inner line taken by the existing bed and must have been the main channel previously. If we look at other air photographs, or at the 1 : 25,000 map, we find the meander completed by an exact replica of this situation, only 1½ miles south of the city. As would be expected, we see there an old spill-way loop that continues and completes the sweeping S-form begun by the 'Acqua Morte', while the modern channel (as in the city) takes the inner bend. Between them is a long, thin island following the curve.

The 'Acqua Morte' line is the earlier, but how old is it? A c. 15th century map<sup>3</sup> shows it as a water-filled loop, separated from the present river bed by a crescent-shaped island with buildings on it.<sup>4</sup> But the still earlier *Carta Rateriana*,

<sup>1</sup> Lugli, *L'Urbanistica dall' Antichità ad Oggi*, 1943, p. 54, puts their modern size as c. 71 × 77 metres. By my calculations, and by Marconi's, they average 75 to 80 m. square (excluding the streets round them); as at Roman Florence, Pavia and Piacenza.

<sup>2</sup> In his article on the Roman 'centuriated' landscape at Lucca, F. Castagnoli has used a war-time air photograph very effectively to show the remaining traces of the course of the river *Auser* in antiquity; it later abandoned this for a shorter course (*Auserclus*) which the modern R. Serchio still follows. The sequence makes an interesting comparison with events at Verona, although at Lucca the open plain gives a different geomorphological setting. Cp. *Studi Etruschi*, XX, 285-90 and Tav. XVIII.

<sup>3</sup> In Biadego, *Verona* ('Italia Artistica' series), 3rd ed., p. 141.

<sup>4</sup> Biadego, p. 148, has a 17th century view of the island which shows long breakwaters projecting from its north end to prevent the main river from reverting to its 'Acqua Morte' course.



apparently of the 10th century,<sup>1</sup> shows one channel only, and Professor Richmond has urged that this represents the river in its 'Acqua Morte' course. If two channels and an island had existed at that time one might expect them to be shown. If the view of the town given by the *Carta Rateriana* can be considered reliable in such matters, then the development of the second, and existing, channel must be later than this. We know, however, that it had formed some time before 1336, when the 'Ponte Nuovo'<sup>2</sup> was built across the present river bed to the island, replacing an older wooden bridge. But the blunt fact is that it is not yet known precisely when the present course replaced the 'Acqua Morte' as the main bed.<sup>3</sup>

We have, however, an archaeological clue to help us with the 'Acqua Morte'. When embanking the left bank of the river, in the late 19th century, traces of the north bridge head (or a pile of the first arch) of the vanished 'Ponte Postumio' were found embedded in buildings 'some distance behind the present river bank. The Roman river evidently came so far over to this side that it was aligned straight towards the 'Acqua Morte' course; and the high banks on either side below the Castel S. Pietro would tend to act as a funnel to send it down this course.

A critical examination of these and other points does lead to the conclusion that the 'Acqua Morte' channel existed in Roman times. Marconi in his useful monograph<sup>4</sup> agrees to this, but he will only allow that it was one of two channels enclosing an island<sup>5</sup> between them, thus eliminating the possibility of a completed eastern corner in the Roman city's plan. However there is no escaping the fact, morphologically, that the 'Acqua Morte' course came first, and in Roman times it could only have been either the main and only river channel, or already a spill-way. To prove Marconi's case, therefore, it would be necessary to show

<sup>1</sup> In Biadego, p. 128; Marconi, p. 10; and *Enciclopedia Italiana*, 'Verona'. Raterius was Bishop of Verona in the 960's; sickened by local rivalries he returned to his monastery in Flanders. The *Carta Rateriana* was included in his MS., formerly in a monastery in the diocese of Cambrai. Cipolla (*Compendio della storia politica di Verona*, 1899, 71) stated that the MS. was lost, believed burnt during the French Revolution, and that the existing copy of this topographical view of the town was made in the eighteenth century. Its details are accurate as far as we can check them, but its perspective is carefree and adapted to fill the space.

<sup>2</sup> Destroyed by the flood of 1882, and rebuilt as the 'Ponte Umberto'. The great embankment walls along the river were built at this time. The position of the 'Ponte delle Nave', originally built in 1373-5, confirms that the width of the 'Acqua Morte' had greatly diminished by then.

<sup>3</sup> One hypothesis might seek a connection with the period 'towards 1154' given by Biadego for the collapse of the remains of the 'Ponte Postumio' (which was not shown on the *Carta Rateriana*, probably because it was in ruins and of only antiquarian interest). It was also, apparently, about the mid-12th century that the Adigetto canal, starting from the Castel Vecchio, was cut across the base of the river's huge loop, primarily for defence but also perhaps to relieve pressure down-stream at a period when river-control was experiencing special difficulty. Verona's history under the Commune is still relatively obscure.

<sup>4</sup> He rejects, as Medieval, the alleged pile of a Roman bridge across the 'Acqua Morte'.

<sup>5</sup> It must be noted that geographers are willing to explain the causation of this island in terms of a spill-way (i.e. a previous course still kept open but of lesser importance) but *not* in terms of a braided river (i.e. the two channels were not equal partners that formed simultaneously as a result of a reduction in the volume of water, leaving an island 'high and dry' between). Verona is too close to the mountains; the longitudinal profile at this point is still sufficiently steep to prohibit a braided river.



that the existing river-bed at this point (e.g. at the 'Ponte Nuovo') is at least as old as the Republican period or earlier. There is no evidence for this and the suggestion cannot be entertained at present.

However, the present crux is now the age of the existing main-stream, rather than of the 'Acqua Morte'; it is a most attractive problem for open-minded investigation.

The conservative nature of the street-plan is matched by that of the girdle of fortifications, whose perimeter is partly shown by Plate 62. The walls of circumvallation were improved by stages<sup>1</sup> throughout the Middle Ages, especially by Can Grande della Scala (14th century), and by Sanmichele (1527 and later). Comparison of the 15th century map, which I have mentioned, with the air photographs, will show that the course of the enceinte has scarcely changed, though it was strengthened by the Austrians in 1814, when one of the four fortresses of the famous 'Quadrilateral'. Only in the 20th century has Verona spread beyond the walls.

#### ROMAN PLANNING AT PIACENZA AND PAVIA

The nodal setting of Piacenza (Plate 63) is so striking as to merit inclusion here, though its plan in some ways merely echoes that of Verona. The outline of its grid of Roman streets is equally well preserved, and is only rivalled by that of its neighbour Pavia. But it is an interesting paradox that there are comparatively few traces of Roman buildings above ground. Like Verona it had outer chains of medieval and later fortifications, though never on as large a scale; these lie on both sides of the Po and agricultural levelling is rapidly adding many parts of them to the field archaeology of military history.

The site became important to the Roman Republic as it commanded an important passage across the Po, an advanced base for any 'big push' to the foot of the Alps in the conquest of the valley. *Placentia* was first founded in 218 B.C., very much an outpost 'in the air'. Even then<sup>2</sup> it was probably intended to be the anchor of a Romanised version of an earlier ancient route down the valley,—although continual fighting in fact delayed the laying of a Roman road (the *Via Aemilia*) until 30 years later, in 187 B.C. By 183 Piacenza had been joined by other new *coloniae* along the road, at Bologna, Parma and Modena. All these towns later received further colonists (veteran soldiers of the Civil War) between 40-20 B.C., and there is still some uncertainty as to how far Piacenza's street-plan was re-developed in this later period.<sup>3</sup>

The square *insulae* of its house-blocks are very clearly seen. They average

<sup>1</sup> For details see Da Lissa, *La fortificazione di Verona*, 1916.

<sup>2</sup> Tenney Frank argued that the town was probably first founded 15 miles to the west of its present site, cp. 'Placentia and the battle of the Trebia', *Journal of Roman Studies*, IX, 1919.

<sup>3</sup> For the history of Placentia, see Prof. G. Mancini's valuable account 'Le Colonie ed i Municipi Romani dell' Emilia Occidentale', in *Emilia Romana*, vol. ii (1944), and Bormann, *C.I.L.*, XI, i, p. 242. For the Augustan rebuilding at Verona, Pavia, etc., see *Papers of the Br. Sch. at Rome*, 1955, 97.



c. 260 feet square, excluding the streets round them,—approximately the same as at Verona. The lines of the *Via Aemilia*, the *Via Postumia*, and other Roman roads<sup>1</sup> boldly converge on this point, and the air photograph conveys visually (and more effectively than much description) the unwavering determination and ruthless confidence of the Roman field-engineers. The axis of the street-plan is taken from that of the *Via Aemilia*. The whole picture, *mutatis mutandis*, gives a forcible impression of what Romanisation meant, and still means, in Europe.

Piacenza in peaceful times is prone to vegetate and to-day it is, it must be admitted, among the less inspiring of Italian provincial towns. But by reason of the site, which lay at the root of its origins, it is in war-time that it comes to the fore, and perhaps it experienced its greatest days, in fact, over 2,000 years ago when first founded.

From this period we have an eloquent record of the dangers and difficulties that could afflict the creation of a new Roman town, and we can also most clearly perceive the rigours that must have accompanied the early attempts at centuriation round it. Placentia and Cremona were settled in the same year as Latin colonies with 6,000 families each, large numbers suited to exposed positions in hostile territory. And for the whole of the first generation both were to be continuously in the 'front line'. It was in the spring of 218 B.C. (ancient tradition stated the exact day, 31 March) that Placentia was inaugurated. Almost at once news came of Hannibal's approaching army, and emergency measures were taken to speed the fortification of the settlement, while all colonists were ordered to be in residence within 30 days (Polybius, III, 40). We may imagine the stragglers, urging ox-carts piled high with household gear. All round, the tribes of the Boii and Insubres took the war-path, swept over the territory just allotted by the Romans, and closely pursued escaping settlers, who found refuge in the Roman town of *Mutina* (Modena). Among these fugitives were the *triumviri*, three commissioners who, we are specifically told, had been sent to allot the lands (all men of high standing, one an ex-consul, the others ex-praetors). They requested a parley with the Boii, who agreed but then seized them as soon as they were outside and took them captive to Hannibal. Back in the embryo town of Placentia only December had been reached before it became the shelter for a broken Roman army, soundly defeated at the Trebia nearby. It was not an auspicious beginning to 2,000 years of urban history.

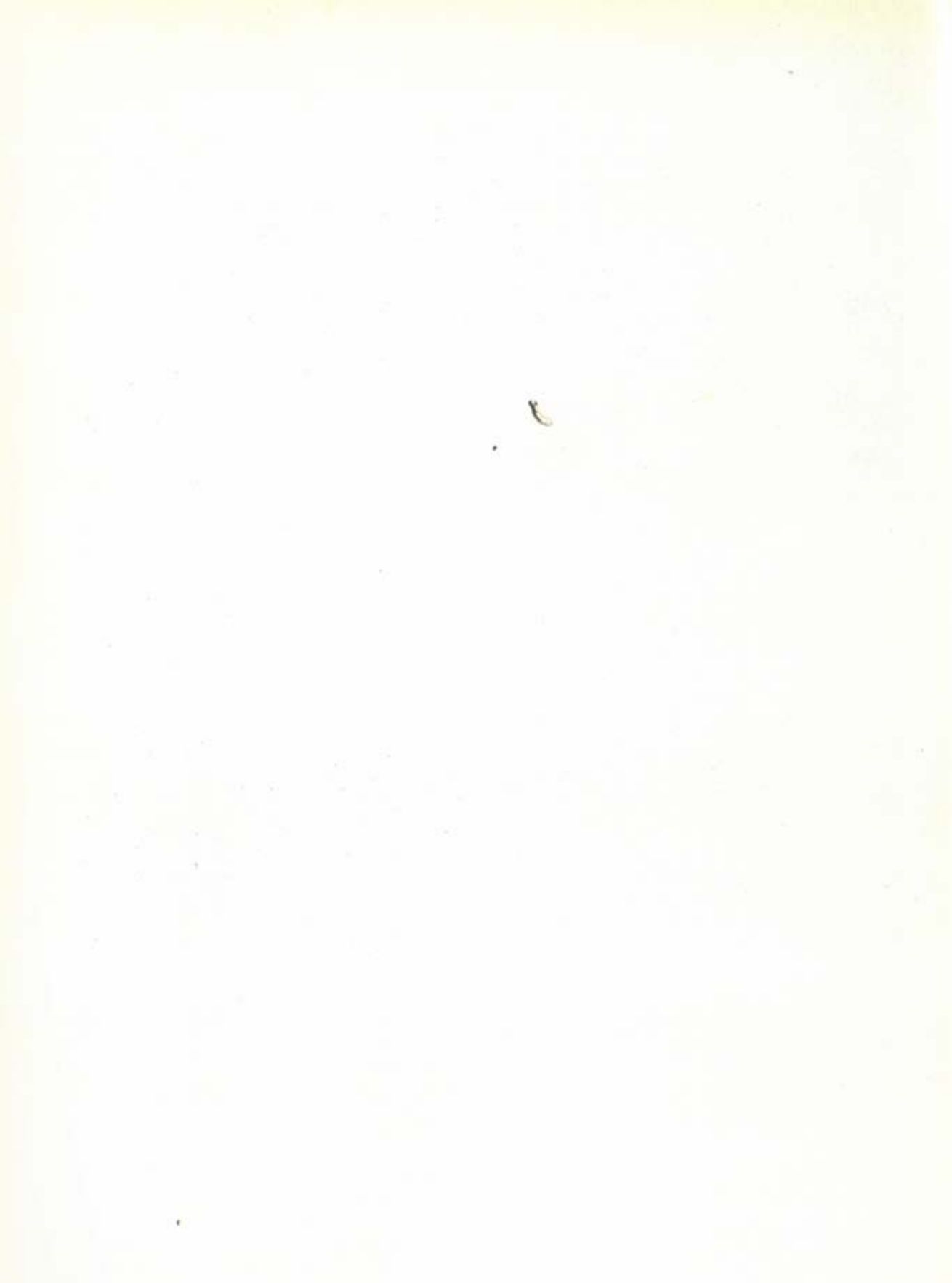
But the colony managed to keep going, and in 207 defended itself against a siege by Hasdrubal. This, and still more an attack by Gallic tribes in 200, reduced it to a sad condition. The Gauls, says Livy, after plundering and burning most of the town, left barely 2,000 men alive among the flames and ruins before they went on to Cremona. Five years later a consular army quartered here was used to rebuild the destroyed portions of both towns, as an emergency measure.

<sup>1</sup> The Roman road that crossed the river Po can be traced from Piacenza to Milan, *Fontes Ambrosiani*, xxv, 1951, 203-11. See also MacKendrick, 'Roman Town Planning', *Archaeology*, 1956, 126-33.





70. SOUTH FRANCE, CARCASSONNE. A contrast in planning. At the top the oval Cité represents the type of the small fortified hill-top town which in Europe dates back into prehistory. There is a double line of walls with levelled ground (the 'lists') between; the lines are mainly 12-13th century with Roman masonry in the foundations. The Cité was 'lord-centred' on its Château. Below is the larger town, on the plain for a growing merchant bourgeoisie. Its gridded plan is not Roman but dates from the 14th century. It is 'market-centred'. See p. 265. Vertical photo. *Crown Copyright Reserved.*

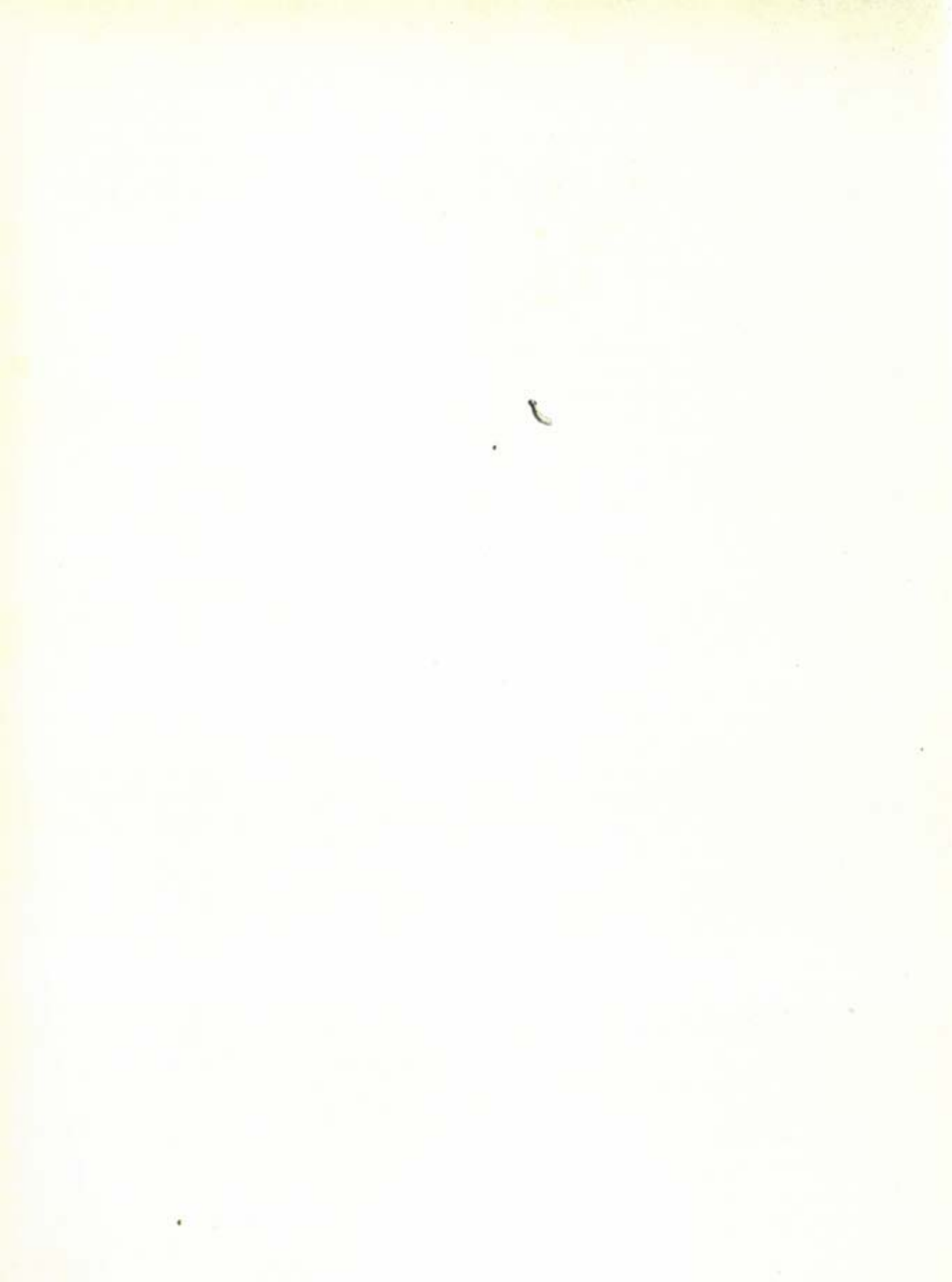






71. DALMATIA, RAGUSA (DUBROVNIK). Settled in the 7th century by Romanised refugees from Slav raids. A well-preserved example of a city-port which was one of the medieval 'Small Powers'. The cultivated coastal strip is sharply contrasted with the bare mountains inland, climbed by a zig-zag road.

See p. 273. Vertical photo. *Crown Copyright Reserved.*





But even in 190 the two were still in the doldrums, and were obliged to send to the Roman Senate a delegation 'who complained of the shortage of colonists, some having been taken off by the fortunes of war, some by disease, while others had left the colonies from reluctance to live with their Gallic neighbours'. 'Reluctance' puts it mildly and Livy's word is *taedium*; the fact could no longer be disguised that after a lifetime of misery and hardship the settlers were, as they would say to-day, 'fed up',—even their *jugera* could not induce them to stay,—and one can scarcely blame them! Events must have played havoc with regular cultivation, leaving ruined farms, grass-grown roads, and raw holdings carved from the 'outback' reverting to bush. To many, farming under such conditions must have seemed '*spes ad vanum et irritum redacta*'; it was a critical moment for the survivors. To save the situation 6,000 more families were dispatched to reinforce Placentia and Cremona. With this blood transfusion, and the arrival of the Via Aemilia and better times, Piacenza was at last securely launched on its long life. It may well be, as Tenney Frank suggested, that the commissioners appointed at this time did more than reinforce Placentia and that they refounded it on a new site, in its present position.

It is natural to add the plan of Pavia (*Ticinum*) beside those of Verona and Piacenza. Although its Roman street-grid is famed for its good preservation, the plan is rarely published<sup>1</sup> and I have not seen an aerial plan of the *ensemble* in any of the works available to me. The layout of the axial streets of *Ticinum* can be clearly recognised on Plate 64. The Roman city was of rectangular shape, longer from east to west than from north to south, and it spread to the river bank as happened at *Florentia*. Its *Cardo Maximus* was aligned towards an important bridge which spanned the river approximately where its medieval successor stands; piles belonging to the earlier bridge have been found. We know that already during the second half of the 1st century B.C. the town was a flourishing *municipium*. The centuriation of its land to the north could tentatively be put at about this time,—and possibly also the street-grid, although this might have earlier antecedents under the Republic. But it is proper to add that neither the rural nor the urban grid is securely dated as yet. The fundamental fact is that the survival of Roman Pavia's plan is a practical demonstration of history. The adamant preservation of its streets testifies to its vigorous continuation of European city life, later as a Longobard capital and as a renowned medieval university.

#### FRANCE: THE OPPIDUM OF GERGOVIA

But it is time, now, that we considered the position in other countries. France

<sup>1</sup> The best topographical accounts are by Taramelli, *Notizie degli Scavi*, 1894, 74-89, and G. Nocca, *Atti del III Congresso Nazionale di Studi Romani*, 1934, 415-22 and tav. LX (sketch-plan). See also Fraccaro, *Atti e Mem. del IV Congr. Storico Lombardo*, 1940, for the centuriation and road communications. Soriga, *Pavia (Italia Artistica series)* reproduces two early views of the city: the fresco of c. 1522 in S. Teodoro and a plan drawn by Claricio in the late 16th century of the fortifications. The angular outline of this later enceinte can be seen on the air view.



offers considerable, and as yet scarcely touched, possibilities of systematic aerial research on prehistoric and historic sites. Its Neolithic 'camps' and its Gallic *oppida* (tribal hill-forts of the Iron Age) are two outstandingly suitable subjects. Plate 69 illustrates Gergovia in Auvergne, a good example of the latter class, to contrast with the urban foci so far described. This is a site whose topographical setting is well demonstrated from the air, but there are other less famous *oppida* of more complicated structure (e.g. those in Brittany) which would prove more suitable for making aerial discoveries. But its historical associations have always given it pride of place,—a focus of that early French 'resistance' movement once described so forcefully by Naomi Mitchison in *The Conquered*.

The famous siege took place in 52 B.C. when Caesar, after subduing Avaricum (Bourges) turned south to strike at the Arverni in their stronghold, Gergovia. Marching down the Allier he would have seen the site while still 20 miles off, and approaching would have watched the massive hill grow to dominate the scene and the road to the south. The steep-sided rectangular plateau rises at its east and west ends to 2,400 feet above sea level and 1,200 feet above the plain; a great natural fortress of commanding aspect with a view of an immense panorama from the top. The summit measures about a mile in length and one-third of a mile across. The terracing on its slopes is natural, but accentuated by cultivation. This air photograph (taken in March) effectively shows the relief<sup>1</sup> by shadows especially along the east and south escarpments, although in consequence of the angle of light the relief of the north slope is less clearly emphasised;—thus exemplifying an inherent difficulty in the photography of such sites. It also adds topographical detail to the French maps on which the plan in the excavation report had to be based.

Part of the rampart along the south and west edges was excavated in 1934-37 by combined Anglo-French efforts,<sup>2</sup> and in one season's work the present writer joined. On the south the defence was a dry-stone wall perched above a vertically scarped rock-face with a flat berm at its foot. The western defence was similar, with a dry-stone wall 7 feet thick. No trace of defences were noted on the north edge, but perhaps landslides had destroyed them. There is only one obvious route (i.e. from the neck of the plateau) by which to enter, and the modern road also follows it, past an excavated Gallo-Roman gateway (Plate 69). The surface of the plateau was split up into small fields or *parcelles* in 1795, belonging to the village of Gergovie visible on the south slope, but long straight boundaries of piled stones were earlier described by Pasumot in 1765 (quoted by Mrs. Brogan).

The site falls into place among the many tribal hill-forts built in opposition to the flooding-in of the Roman armies ever deeper into Gaul towards the Atlantic coast. 'For a brief breathless space Gergovia became the centre of

<sup>1</sup> For another air photograph of Gergovia, cp. Chombart de Lauwe's *Photographies Aériennes*, 1951, figs. 84-5; the direction of light was less satisfactory for showing the relief.

<sup>2</sup> See O. Brogan and E. Desforges, *Arch. Journ.*, 97, 1940, 1 seq.



Gallic resistance. Whether the line which Vercingetorix drew for his fortress happened to enclose a Gaulish village or a chieftain's dwelling we cannot tell. No such trace has yet been found, but the plateau is large. . . . But it may be stated with confidence that, whether or not there was some Iron Age settlement on the hill-top, the great area enclosed by the defences was due to military requirements and not to the need for defending a large Gaulish metropolis'.<sup>1</sup> After the resistance movement had collapsed a fairly large community continued to cling to this bleak mountain top, but by the 2nd century A.D. the last remnant had abandoned it for the plain below (with its newly founded Roman town of *Augustonemetum*, Clermont), until only two small Romano-Gallic temples remained. Gergovia is a good example of those transitory prehistoric forts which never grew into towns.

### CARCASSONNE

The choice of Carcassonne (Plate 70) to represent the fine medieval town plans of France was made after consideration, for several reasons. To begin with, the contrast between the 'old style' Cité on the hill and the 'new style' Bourg across the river shows clearly, within the compass of a single photograph, the differing character of the primitive hill-top refuge town of jumbled streets (occupied continuously from Roman times) and the larger planned creation of the latter part of the Middle Ages in which trade was the prime consideration. It would be difficult to find better examples of these two fundamentally different types of town in such close proximity and relationship; and, in a sense, 'Looke heere upon this Picture, and on this', would seem almost sufficient comment. But while both have attracted so much attention they are usually illustrated apart; and even such an authority as Lavedan omits their plans altogether in his *Histoire de l'Urbanisme—Antiquité-Moyen Age*.

In the present context we need only recall a few essentials of their history. The Cité stands on an isolated hilltop,—an acropolis siting of the type which an Iron Age Gaulish hill-fort refuge naturally chose. But its known history begins as a fortified Roman town commanding the important road-crossing over the R. Aude. In c. 436 A.D. it was occupied by Visigoths in their sweep across France, and continued as a Dark Age stronghold. For a brief period in the 8th century it was seized by the Arabs. For many centuries after this it had a natural importance as a pivot in the frontier 'march' between the feudal powers in France and Spain. Besides the Roman substructures, French archaeologists in the past have distinguished three chief building-periods in the defences, (a) 5th century 'Visigothic',<sup>2</sup> (b) 12th century, by its hereditary counts the Tren-

<sup>1</sup> *Op. cit.*, 23-4.

<sup>2</sup> But according to other and recent opinions, the 'Visigothic' structures are more probably late Roman. I have to thank Mr. C. E. Stevens for information on this point.



cavels (especially the château), (c) 13th century, by the French Kings (notably the circuit of the outer wall).<sup>1</sup>

In the 'crusade' against the Albigenses that began in 1209, the feudal nobles of the north of France set themselves implacably to conquer those of the south and ended in wrecking the brilliant Provençal civilisation. Their ruthless ambitions and the operations of the Inquisition in wiping out 'heresy' can be read of elsewhere. These blood-stained years are among the saddest and most shocking of the whole Middle Ages. The power of the Cité was dimmed, when finally annexed in 1240 to the Capetian monarchy. Louis IX at once ordered the 'proscrits' from the Cité to be settled on a new site which was begun at its foot on the same side of the river, but in 1262 the king moved his new Bourg to the opposite bank. In 1314, merchants asked for royal permission to put up additional buildings at their own expense, and requested as a 'quid pro quo' that the king should concede them the right to two annual fairs and a market. This bargaining was an interesting and curious episode. In 1355 the bourg was burnt by the Black Prince and rebuilt on the chess-board plan.<sup>2</sup> The original circuit of its walls is today represented by the tree-lined boulevard. The street-plan of the Cité was focussed on the Château,—'lord-centred'; but in that of the new town it was the market-place that had the dominant position.

#### ITALY: MEDIEVAL PLANNING AT CASTELFRANCO, CITTADILLA, AND THE SITE OF LE MOTTE

I should have liked to include here an extensive series of air photographs of 'villes neuves', which so well illustrate certain features of medieval town-planning, but I must postpone this to another occasion. The *bastide* in France, the *borgo nuovo* or *casale* in Italy, and similar 'de novo' foundations in other parts of Europe are very suitable sites for study by air photography,<sup>3</sup> with their systematised or gridded plans. Researches on the structure of such town plans, and the arrangement of the chief elements in them, have already given much useful social and economic material for the period. Even formally, their regular street-systems are of interest, as illustrating an aspect of medieval thinking which

<sup>1</sup> The double line of walls with 54 towers which crowns the hilltop is in some ways the finest surviving example of 11th to 13th century fortification in Europe. The outer circuit measures over 1,600 yards. There were only two entrances (on east and west). The Château, built against the inner wall, is surrounded by an enormous ditch crossed by a single narrow bridge, which is protected by a semi-circular barbican. There was formerly an outwork below the hill, towards the river. One of the two river bridges is medieval, the other modern. The protests by Prosper Mérimée and others (1835-50) against the steady destruction of the walls led to the well-known restoration by Viollet-le-Duc (1855-79).

<sup>2</sup> 'La proportion des échiquiers réguliers s'accroît sensiblement à la fin du XIII siècle et au début du XIV'; cp. Lavedan, *op. cit.*, 367, with examples.

<sup>3</sup> This has never yet been attempted systematically. Many important sites of this kind are still imperfectly mapped or insufficiently known. Lavedan included an oblique aerial view of Aigues Mortes in his *Histoire de l'Urbanisme*, vol. i, plate XV; and also one of Bram and of the Cité at Carcassonne (pl. XIII).



is sometimes overshadowed by the apparent lack of attention to planning which often appears to dominate the medieval scene.

It was not easy to choose one or two to represent those in Italy. Finally, I selected a group of three neighbouring sites apparently related to one another,—and presenting an interesting and unfamiliar problem in archaeology. In 1952 I visited them to compare, and examine, the ground and air appearances.

These sites lie close together, strung out in a straight line, from 26 to 28 miles N.W. of Venice in a very fertile, flat and monotonous landscape which can have changed little since it was partitioned by the grid of parallel Roman roads ('centuriation') which still survives and lends it some additional interest to the archaeologist (see Plate 66). Ordinarily, the traveller's eye would hardly notice these parallel lines, obvious though they are from the air, for it is very 'close' country, with visibility restricted to a minimum by innumerable hedges and trees along the inter-field ditches. The first of these sites, Castelfranco Veneto (Plate 65, A) was founded in 1199 by the people of Treviso<sup>1</sup> as a fortified outpost against those of Padua. In 1210-11 came the *riposte*, the foundation of Cittadella (Plate 65, B), only 7 miles to the west, as a rival colony, constructed by the Paduans. Its architect, it is said, was Benvenuto da Carturo.

Both of these new towns were, initially, sited for military ends;—at the crossings of a west to east route with others from north to south. Both were girdled with a towering wall of red brick on top of a steep earth rampart that was built of the soil excavated from a broad water-filled moat dug all round. High towers and symmetrically opposed gateways completed the defences. Both conformed to the accepted military principles of the day in outward essentials,—but in their internal planning<sup>2</sup> it would be natural that such conscious rivals should choose differing methods. Castelfranco is a square within a square, an inner street repeating the line of the walls, while Cittadella is divided by long parallel streets, themselves crossed by others, designed as a perfect grid of square house-blocks resembling Roman *insulae*.

It is recorded that Castelfranco took ten years to complete, and employed 1,000 labourers, plus 500 bricklayers under a master mason with 4 assistants. Once built, 100 families of good birth were sent there, with grants of houses and farms, exempted from taxes (hence its name, *castrum francum*). Administration was in the hands of two councils; and fourteen *castelli* and twenty-seven villages were also under its authority. The commune of Treviso also sent, as its special representatives, two consuls aided by twelve guardians. The political, civil and penal codes were Trevisan too, and lasted up to the fall of the Republic of Venice in 1797. It was not long before Castelfranco was put to the test, for in 1215 and again in 1220 it was besieged by the rival Paduans. A little later

<sup>1</sup> The *Enciclopedia Italiana* in its article on 'Città' (p. 487) incorrectly states that Castelfranco was built by the Paduans, and Cittadella by the people of Vicenza. But in its articles on 'Castelfranco' and on 'Cittadella' the correct founders are given.

<sup>2</sup> The best detailed street plans are those in the large Italian atlas *Atlante dei Tipi Geografici* (Tav. 71), from the 1 : 25,000 map series.



it came into the hands of Ezzelino da Romano, the ambitious *podestà* of Verona. He held the Italian approaches to the Alpine passes secure for Emperor Frederic II, who stayed at Castelfranco on several occasions. It retained a military importance up to the early part of the 19th century, as a nodal point of strategic roads, and a key-point in both Austrian and French campaigns.

So far I have only been concerned to illustrate these two excellently preserved examples of medieval town-planning, which are still insufficiently known.<sup>1</sup> I wish to turn now to an interesting and mysterious earth-work that lies between them (Plate 66). This is the site marked on most maps as *Le Motte*, 4.7 km. due west of Castelfranco, and 1 km. south of the west-east line of the trackway which marks the Roman *Via Postumia*. The survival of a complete ancient earthwork amid the intensive cultivation of the Po-Valley is notable in itself. Plate 66 shows its plan today,—a large and impressive rectangle, *c.* 250 × 200 metres, enclosing an area about equal in size to the interior of Castelfranco. Plate 67 shows ground photographs of the rampart, up to 15 feet high, steeply sloping on both its inner and outer face. It is complete on all sides except on the east where part has been levelled by a farm, and it is apparently of piled-earth construction (as far as could be seen from a section on the east side, which we examined in 1952). The soil was obtained from a broad ditch outside, now almost levelled and filled by cultivation. Inside, the ground is absolutely level, without any traces of substantial permanent occupation. Only excavation, of course, could reveal the post holes of timber buildings. The line of an ancient trackway leads directly to *Le Motte* from the north-west, and there was probably an entrance to the site at this point. This old road runs in a straight line for 2 to 3 km., though some of it survives only as a field-boundary. It crosses the track of the *Via Postumia* obliquely, and as if the latter was then of little importance.

Parallel with the *Via Postumia*, and with each other, run the west to east lines of minor roads at regular intervals, four of which are very clearly seen on Plate 66; these represent part of the surviving framework of land partition by the Roman method of 'centuriation' described in Chapter IV. The topography, and traces, of this great system of Roman agriculture, between *Patavium* (Padua) and *Acelum* (Asolo), have been admirably described by Professor Plinio Fracaro.<sup>2</sup> I have already commented on them (pp. 168 and 169), and it will be enough to emphasise here that 'Le Motte' is clearly a later interpolation, and pays no regard to them.

Local archaeologists have occasionally attempted to date this site, which in spite of its size is comparatively unknown outside the region, and is still an open problem. The best account, hitherto, is in the volume by Alessio De Bon<sup>3</sup>. He

<sup>1</sup> Lavedan, for example, in his famous *Histoire de l'Urbanisme*: vol. i, *Antiquité—Moyen Age*, 1926, does not mention Castelfranco Veneto, and gives one line (but no plan) to Cittadella, which, he said, was built by the Venetians!

<sup>2</sup> In *Studi di Antichità Classica Offerti a Emanuele Ciaceri*, 1940.

<sup>3</sup> *La colonizzazione romana dal Brento al Piave*, Bassano, 1937, p. 131 seq. De Bon mentions (p. 136) an



could find no trace of Roman pottery or roof-tiles inside the ramparts, and neither did my search in 1952. But he concluded that it should probably be considered a camp of barbarian auxiliary troops of the late Roman Empire, although he admits that the absence of any finds which could support this view is strange.

However I do not think it is necessary to seek this hypothesis. I would suggest another possible explanation, which seems better to fit the facts as far as we know them. The site is perhaps to be understood best in relation to the medieval archaeology of the neighbourhood, and to Castelfranco and Cittadella in particular. Le Motte stands watchfully adjacent to the road between them (see Plate 66)—an important medieval west-east route as I have shown above, and apart from this there is no obvious explanation for the position chosen for this site. Its well-preserved earthen rampart, in character and profile, is similar to that of Castelfranco, although of course much smaller. In a short-lived or temporary fortification a palisade on top would take the place of a wall. From its close proximity (3 miles) to Castelfranco it is improbable that it was ever intended as a new township, even by Castelfranco's rivals.

But Le Motte might well be connected with the sieges of Castelfranco by Paduan forces in 1215 and 1220, as a siege-camp for the heavier baggage, fortified against attack; at a safe distance from a surprise sortie by the townspeople,—and also as a forward base from Cittadella along this important road. Perhaps a map which names it 'Motte di Ezzelino da Romano' has preserved a correct tradition. He<sup>1</sup> was very active in campaigns in this area, while attempting (successfully) to lay his hands on Castelfranco and other towns, during the second quarter of the 13th century. In either case, the function of the site would have been similar, and the difference only a matter of a few years. Even a later date would not be out of the question, for during the 14th century Castelfranco was an important nodal point in the struggles large and small within this cockpit of the 'Marca'. Ludwig of Hungary tried in vain to capture it, in 1357 and in 1378.

Excavation (not yet attempted) is naturally required,—but special attention would have to be given to the traces *in the soil* of the plans of temporary structures, e.g. timber buildings, palisades, etc., in post-hole form. The technique would be the same as that already perfected for excavating prehistoric hill forts in Western Europe, and now applied also to medieval sites in England, Scandinavia and Switzerland. But the field archaeology and excavation of medieval sites in Italy has still a long way to go. The examination of a suspected siege-camp would be a valuable contribution.

---

earthwork at Castello di Godego, a mile or two N.E. of Le Motte, which was also formerly thought to be Roman or even Gothic but now is believed to be Medieval.

Other comparisons with Le Motte would be two rectangular earthworks on the plain east of the Tagliamento, 'Il Castelliere' near Gradisca, and 'Il Castelerio' near Savalons (map sheet 25, III, S.W.). Compare earthwork S.W. of Trebasileghe, S.W. of Treviso (Sheet 51, IV, N.W.).

<sup>1</sup> Ezzelino III da Romano (1194-1259) the warlike ruler of Verona, Vicenza and Padua. Married (1238) Selvaggia, natural daughter of Emperor Frederic II.



Finally, it is of interest to compare this earth-work with the plans of others, of proven medieval date, which I recorded from the air in Apulia in S. Italy; particularly with the rampart round the abandoned 13th century village of Il Casone;<sup>1</sup> and with the innermost rectangular earth-work of the deserted medieval village (and *palacium* of Emperor Frederic II) at San Lorenzo.<sup>2</sup> As all those Apulian medieval earth-works are to be discussed in detail in a Report of the Research Committee Society of Antiquaries, covering the field-work and excavation under my charge in 1949-50, I must not anticipate; and it must suffice to refer to the results already published in preliminary articles. I may make mention, however, of the earth-works of a suspected medieval siege-camp of the Angevin forces (perhaps of Charles II in 1300) set up a mile or two outside the town of Lucera, which we mapped from the air, and have briefly recorded in an Interim Report.<sup>3</sup>

### THE FORTRESS OF PALMANOVA

Air photography is a particularly appropriate and useful method of recording and comparing the surviving examples of the immense sprawling plans of fortifications in the early Age of Gunpowder. Some are well mapped and studied,<sup>4</sup> a few hackneyed by too frequent illustration, but many are poorly published or known only to a limited degree (even though their literature, as a whole, is copious and extends back to contemporary<sup>5</sup> sources).

The artificial and specialised nature of these defences has already made them a part of the archaeology of the Recent Past. Many are being damaged or levelled as towns expand, and the study of some of them runs great risk of neglect until it becomes too late. The Balkans can show particularly interesting examples, connected with the offensives and counter-offensives on the swaying frontier of the Ottoman Empire and Christendom in the early 18th century. The great fortresses of Petrovaradin (Novi Sad) and Komarom on the Danube, and of Arad,—to mention only three of the finest,—with their concentric rings of overlapping angular lines of ramparts resemble the huge blossoms of prize chrysanthemums! Karlovac is also a good case. In the later 15th century the gun had been more than a match for walls of medieval build, but in the 16th century, as Sir Charles Oman pointed out, the resources of scientific fortification developed so fast<sup>6</sup> and so far that for a time it curtailed the domin-

<sup>1</sup> See 'Buried Landscapes in Southern Italy', in *Antiquity*, June 1949, plate Vb.

<sup>2</sup> *Ibid.*, plate VI.

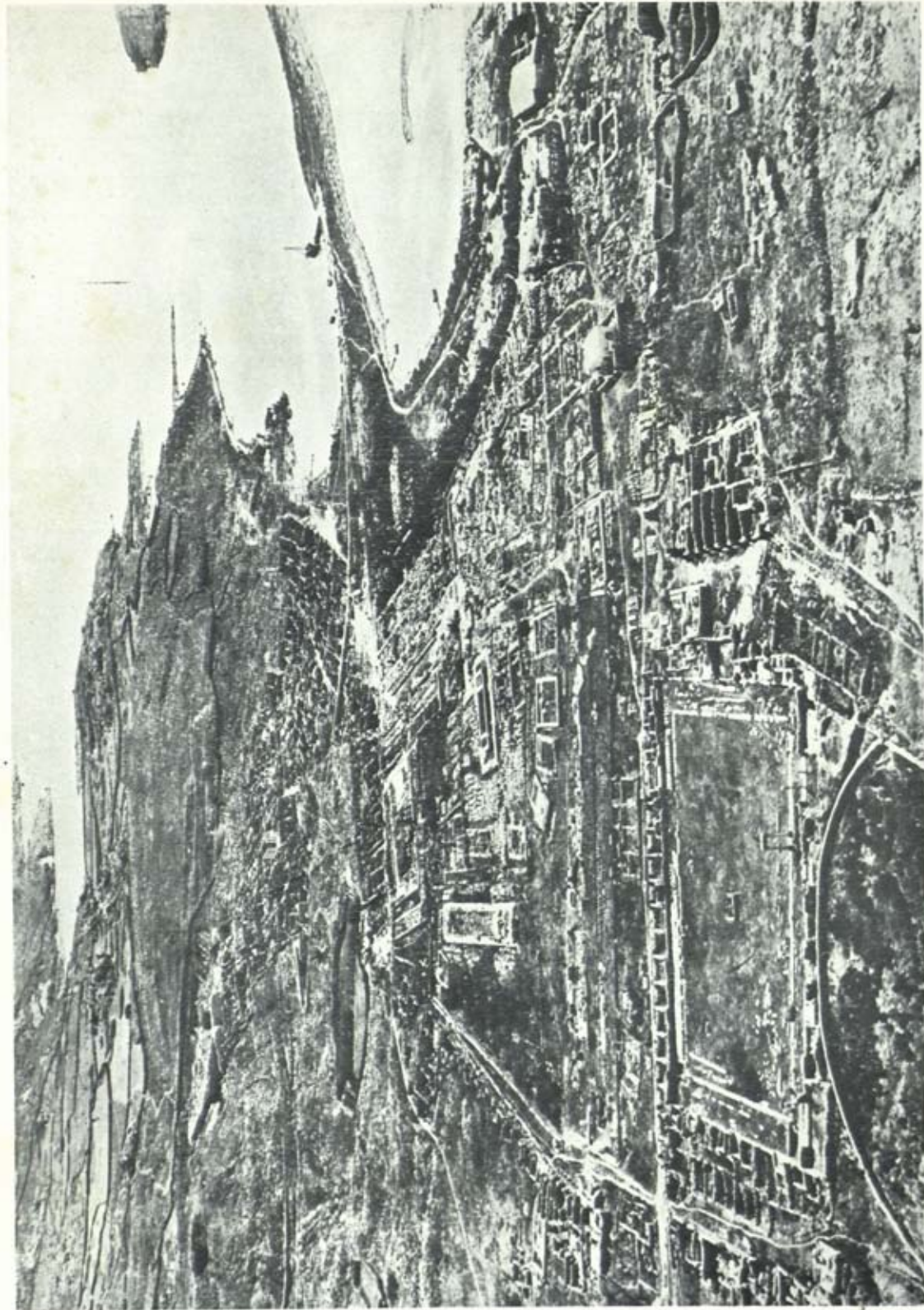
<sup>3</sup> *Antiquity*, June 1950, p. 91.

<sup>4</sup> E.g. those in Prof. F. L. Ganshof's excellent monograph, *Etude sur le développement des villes entre Loire et Rhin au Moyen Age*, Bruxelles, 1943.

<sup>5</sup> In the 16th century, artists, princes, and men of letters were all concerned with the concept and planning of new 'ideal' fortified cities. Dürer, for example, drew a fine regular 'blue-print' plan for one (1527). The work of the 16th century German, D. Speckle, and of Perret and Vauban in France, is well known.

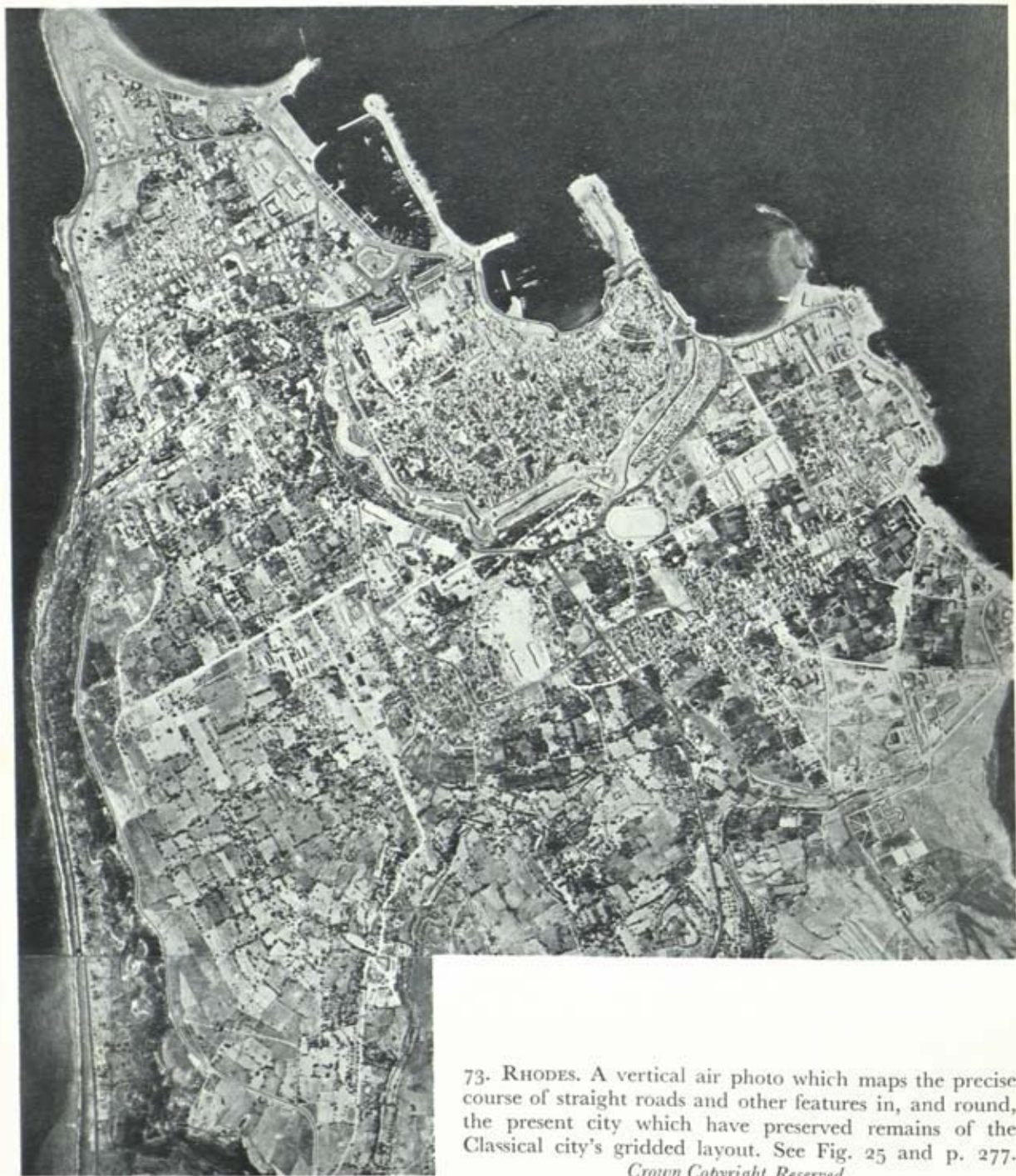
<sup>6</sup> It is not intended to belittle the often decisive rôle of artillery in the field battles of the period. These





72. DELOS. Oblique view of the Hellenic city looking south. *Bottom left*: remains of the Sacred Lake, with the rectangular Agora of the Italian traders behind. At the centre of the photograph is a group of sanctuaries. Beyond, on the coast, were the commercial quays. See p. 274. *Photo: Greek Government Geological Service.*





73. RHODES. A vertical air photo which maps the precise course of straight roads and other features in, and round, the present city which have preserved remains of the Classical city's gridded layout. See Fig. 25 and p. 277.  
*Crown Copyright Reserved.*



ance of the artillery. Hence sieges of strongpoints became frequent and pitched battles rarer. 'The engineer replaced the old high-lying walls of towns with new, low, bastioned enceintes, shielded with ditch and glacis, and thickly gunned on points that gave cross-fire. The fortification of places like Milan or Verona was an immense task, but well repayed the trouble and expense.'<sup>1</sup>

Up and down Europe techniques of defence were called forth by those of attack, as always,—and before 1600 all kinds of hornworks, demi-lunes, redans, and ravelins, besides the elaborate use of water-defences against mining, had gone to the making of a profusion of fortresses of astonishing complexity, with a form of linear defence in depth which today already seems only a little less antediluvian than the serried lines of ramparts in Iron Age hillforts, evolved to oppose the intensified slingstone warfare of the 1st century B.C.

The most remarkable example of a fortress city in Italy built *de novo*, is that of Palmanova (Plate 68), 11 miles from Udine. It is also the most notable town to be founded in Italy in the 16th century, and its magnificently symmetrical star-shaped defences<sup>2</sup> make it almost the finest example of this style of fortification surviving in Europe. As compared with Neuf Brisach,<sup>3</sup> it is only rarely illustrated. From the air its formal plan achieves its fullest effect, and provokes mingled feelings of amazement and admiration that would have greatly gratified its architects, who planned it from the level plain. Starting from the hexagonal piazza, three main roads (orientated with an equal angle between each) set off in dead straight lines to pass through massive fortified gate-houses of square plan, built round an inside courtyard like those of a Chinese city. The north-west gate-house is the Porta Udine, the north-east points toward Gorizia, and the south towards the head of the Adriatic 16 miles away. It thus stood sentinel over the exits of the mountain passes down into N.E. Italy, like a cat watching several mouseholes at once. The diameter of the built-up area of houses and barracks inside the rampart is 800 metres, and the overall diameter including the multiple moats, bastions, lunettes, etc., is 1,800 metres. The street plan and every detail of the fortifications have been executed with most exact symmetry. The town never grew outside its defences, which are now of no military significance and are of purely archaeological interest. The townspeople, today,

rapid changes in warfare moved too fast even for some of the sharpest and most scheming minds. Nothing would have stung Machiavelli's conceit more than to have been told he was out-of-date, but, as Sir Charles Oman showed (*A History of the Art of War in the 16th century*, pp. 93-4, and 150), he was notably behind his times in his policies for the use of firearms advocated in *Arte della Guerra*.

<sup>1</sup> Oman, *op. cit.*, p. 28.

<sup>2</sup> Cp. the similar, but far less impressive, hexagonal perimeter defences round Grosseto, built between 1575-90. Another example of an Italian fortress town of this period, with very symmetrical defences, is Sabbioneta near Mantua, founded *de novo* in the latter part of the 16th century. For plans, see *Atlante dei Tipi Geografici* (ed. O. Marinelli), 2 vols. (text and maps), publ. by Istituto Geografico Militare, Firenze 1948.

<sup>3</sup> For air photographs of the star-shaped defences of Neuf Brisach and Bergues see Chombart de Lauwe, *Découvertes Aériennes du Monde*.



pride themselves on their agriculture, and although cultivation is making some small encroachments on the outer defences these have been fortunate to fossilise in peace in the depths of a rural countryside.

The fortress city of 'Palma Nova' was built by the Republic of Venice to guard its frontier territories against the threat of Ottoman Turkish invasion down into the fertile Friulian plain, and against the territorial greed of the archdukes of Austria. The need for such a fortress was put forward in 1566, but it was not until September 1593 that the Venetian senate finally acted. The design of the defences is said to be due mainly to the Counts Marcantonio Martinengo di Villachiera and Giulio Savorgnan. The first stone was laid on 7th October, marking the 22nd anniversary of the great victory over the Turkish fleet at Lepanto; progress was fairly rapid. By the early years of the 17th century, Palmanova had become one of the foremost strong-points in Europe, and it was kept up-to-date militarily by Venice. But, like more than one leviathan designed for war, it never played an active part of major importance. In 1809 it was besieged by the Austrians and freed from the French. In Austrian hands, later in the 19th century, it was disarmed and demilitarised, and now has already become an archaeological site, left high and dry like a stranded star-fish.

Palmanova is a useful reminder of how closely the heart of Europe was menaced by an Islamic power at a time not so far distant historically,—a high tide from the East, not the first to recede. And Palmanova's serried lines remind us, too, of how instructive it is, technologically (and archaeologically, in the broad sense), to follow the evolution of permanent fortifications throughout the succeeding centuries. The best 17th century designers, like Vauban (1633-1707), were essentially practical. Vauban used to say 'one does not fortify by system but by common sense'. Although his plans were elaborate they were adapted to the terrain.

Nevertheless in the 17th and still more in the 18th century, stylisation increased, ideas began to fossilise, and conservatism was maintained into the 19th century. To attempt new methods was to display ignorance, and orthodox engineers concentrated on improving details instead (though original minds like Montalembert's were here and there at work). The lay-out of the new defences at Antwerp which were begun in 1859, two and a half centuries after Palmanova, have been described as 'the last and finest expression of the medieval enceinte'. It is really not until the very end of the 19th century that we move suddenly and forcibly into the modern phase of fortification, with the arrival of the 'obus torpille' or long shell with high-explosive bursting charge (tested with such dramatic effects against the walls of Fort Malmaison in 1886). It was thought at first that the days of permanent fortification were over! Thus the wheel had turned a full circle,—from the first spurt of inventiveness, its gradual levelling off, and then the fresh impetus,—an evolutionary cycle of a familiar kind but one always worthy of attention.



## DALMATIA: RAGUSA

The plan and siting of Ragusa<sup>1</sup> (Plate 71) on the Dalmatian shore of the Adriatic illustrate the character of a medieval mercantile city, which had a will of its own; a type of polity (like Pisa and Genoa) of such importance formerly in the Mediterranean and yet already archaic today. Maintaining varying degrees of independence, living by trade and their own sea-venturing, such communities were in many ways the heirs of the Mediterranean city-states of the Classical world. Like the latter, Ragusa had its own fluctuating strip of coastal territorial possessions; and a distinctive vitality in art and commerce sustained, and periodically renewed, by its maritime position.

If we ignore the scattered houses on the narrow cultivated belt between the steep barren mountain-side and the compact town which are mainly modern, the aerial view gives a faithful impression of the form of this fortified medieval port, clinging to the bare coast like a brilliantly coloured sea-anemone to a rock. Tenacious and well-protected, it was also limpet-like in its obdurate resistance to the continuous external perils that filled its history.

Another reason for my choice of Ragusa is that its origin was closely linked with events at the Roman city of *Salona*, further up the coast (see p. 185). There, as we have seen, the surviving Roman townsmen in the Dark Ages took refuge in nearby *Spalato* (Split). Similarly, the history of Ragusa began in the 7th century A.D., when refugees from the Roman town of *Epidaurus* (Cavtat) a few miles down the coast, escaping from raiding Avars, established themselves on the small island of *Ragusium*, which can have been little more than an inhospitable crag, obviously identifiable today with the upper part of the present town on its seaward side. Next, a colony of Slavs settled on the shore just opposite, probably as a result of the great southward movement of the Slavs in the 7th century, ejected from an earlier homeland round the Pripet marshes by the Avars. At Ragusa, the marshy creek separating the two settlements was afterwards filled-in and levelled-off, and the communities came together to form a fertile union of Latin and Slav civilisations.

The air view brings out clearly the main topographical features. The original island or *presqu'île* is easily discernible in the plan by its jumble of ancient buildings closely-set along the cliffs next the sea. The lower town, standing on the less stable foundations of the area filled-in, is distinguished by its fine regular planning, with parallel streets of tall stone houses;—dating from the great rebuilding of this part of the town after the terrible earthquake of 1667 (whose disastrous effects can be seen in Apulia too, across the Adriatic). The circuit of massive medieval walls and the wide rock-cut fosse outside are well preserved on the landward side, and the wall is continued all round the seaward side. The

<sup>1</sup> Ragusa is one of the two ports, separated by a headland, which today are together called Dubrovnik. That to the north is modern, known as Port Graz; the old port (Ragusa) to the south-east, is called Port Kase and is now of small importance. As I am discussing its early history I shall refer to it by its older name.



big round bastion at the corner is the Minčeta Tower built in 1464,<sup>1</sup> but the defensive perimeter, with its square towers, is appreciably earlier.

The harbour, by modern standards, seems small for a port once so famous for its sea-power. Inside, the present depth is about 12 feet, suitable for small vessels only. South-easterly winds make it difficult to enter at times, and also the anchorage outside is exposed to winds from this quarter which drive-in a heavy sea. The nature of the harbour helps one to appreciate the relatively limited requirements of early navigation. Yet in the Middle Ages the ships of Ragusa were famous for their trade to Egypt and Asia Minor, and at the peak of prosperity its fleet is said to have totalled 300 vessels. As late as the 19th century it still had some importance for ship-building.

In the early Middle Ages, Byzantium, Venice and Hungary laid hold upon Ragusa in succession. It profited from the classical learning introduced by Byzantine scholars after the fall of Constantinople in 1453, and by the Renaissance. Activity here from 1450-1650 was such that it has been called the 'South Slavonic Athens'; at this time it was a quasi-independent republic, with a ruling oligarchy of nobles, merchants and shipowners, over whom presided a 'rector' chosen each month. Diplomatic skill, no less than its walls, safeguarded the city against its greater neighbours. From the later 17th century a decline set in gradually, while Venice made constant and covetous attempts to obtain or eliminate her lesser rival. In terms of its environment and site, an aerial plan of present-day Ragusa still provides a good example of one of the medieval 'Small Powers' which was able to make remarkably successful use of the restricted opportunities offered by Nature, and it once more shows on how small a scale, geographically, the local conditions for such power could be. Even today, its particular vigour and originality are still made evident in an annual Festival of Arts which has a European reputation. Europe and the New World owe much to the traditions and independent ways of such medieval mercantile communities, even to the smallest,—and there is still plenty of life left in such ancient landscapes to help to leaven the lump of mass-produced industrial civilisation.

#### THE AEGEAN: DELOS

Relatively small use has been made of systematic air photography in Greek archaeology as a whole, although some reconnaissances have been made by Greek government departments before the war and since, and excavation reports now and then include an isolated aerial view. In the last ten years I have examined many hundreds of British air photographs taken in Greece during

<sup>1</sup> This famous bastion was built by a Florentine architect at the time of the great Ottoman advance into the Balkans. Until late in the 19th century the Turkish frontier was only two hours walk from the centre of the city. For the age-old antithesis between communities on the Dalmatian coast rooted in the Classical Mediterranean world, and the more primitive hinterland with its continental ties, see my comments on Salona, p. 189.



the war, in search of sites of various kinds. Examples of discoveries have already been discussed (Chapter I, p. 29 seq.). Such photographs, however, were not taken under the conditions best suited for archaeological discoveries,—although they have yielded them nevertheless. There is little doubt that if the correct methods of air photography were applied to appropriate sites and regions in Greece and the Aegean islands, important finds would result. A dense covering of olives and vines severely restricts the possibilities in many areas, but crop-mark sites could be expected in the arable plains in the north (when these are not divided into thin strip-fields); and ancient cultivation terraces, off-shore features of ports, and the outlines of building-foundations (where the ground is clear of trees and vines) are all potential subjects, given the use of methods suitable to reveal them. So much, at least, can be forecasted on general principles that apply in Greece as in other similar Mediterranean lands. Personal knowledge of specific topographical problems could suggest all manner of other suitable subjects.

There is also a secondary use,—that of demonstrating, from a fresh standpoint, the topography of large and complex sites that are difficult to visualise in their entirety at ground level. The photograph of Delos<sup>1</sup> on Plate 72 serves as an example. It cannot, of course, be expected to disclose any structure that was not previously known from the systematic excavations of the French School at Athens. None the less, this oblique view is useful for its comprehensive picture of the heart of the Hellenic city (seen as if from a portable hill-top), and for the way in which it brings out so clearly the intercalation of the alternating sacred and commercial zones,—a tangible illustration of that ambivalent devotion to religion and to worldly riches that was both the strength and weakness of this island city. The origins of the peculiar sanctity of the island are barely discernible in the dawn of history, but throughout classical times it was the renowned sanctuary of Apollo which lorded it with ceremonies and games. 'C'est avant tout, la religion qui fit la fortune de Délos, roc ingrat et médiocre mouillage. Mais on ne s'étonne point qu'un sanctuaire fameux soit devenu un grand port de commerce'.<sup>2</sup> By the period of its final disasters in the early 1st century B.C., a rising and feverish prosperity had raised it to a unique position among the *entrepôts* of the eastern Mediterranean.

This oblique air view was taken looking due south, with the merchant quarter round Scardona Bay behind us.<sup>3</sup> In the left-hand corner lies the enclosed oval

<sup>1</sup> The bare rocky island of Delos, between Mykonos and Rhenea in the Cyclades, is no more than  $2\frac{3}{4}$  miles long and  $\frac{3}{4}$  mile at its widest. There was always an essentially vulnerable and artificial quality about a great city in such a setting.

<sup>2</sup> Pierre Roussel, *Délos*, 1925.

<sup>3</sup> Definitive descriptions of the city's buildings will be found in the volumes published by the French School at Athens. Vol. IV, pt. i (1911), deals with the topography of the island, and includes attempts at comprehensive photographs of the site from surrounding hillsides, but these are too distant to provide the equivalent of air photography. The latest plan of the site is that in Kontoleon's 'Ὁδηγὸς τῆς Δέλου', Athens, 1950.



of the Sacred Lake,<sup>1</sup> and behind it the great rectangular Agora of the Italian traders which monopolised a 'key' position in the plan. Beyond, and at the centre of the photograph, is the compact sacred quarter with a congeries of rectangular sanctuaries grouped round the Temple of Apollo; and behind these yet another Agora and the packed streets of the business and residential quarter round the Theatre. On the right of the picture lies part of the Sacred Harbour with the tip of its protective in-curving mole visible on the edge of the photograph.<sup>2</sup> Along the shore-line, beyond, stretched the commercial quays and docks fringed with warehouses, almost as far as the next bay in the distance. Many of these structures are partly eroded on the beach, or awash in low water;<sup>3</sup> and the details of these quays and basins could very profitably be elucidated by air photography, following the experience already gained in the aerial investigation of ancient Mediterranean ports (cp. p. 41). Another suitable subject for aerial mapping would be the extensive areas of ancient terraced fields,<sup>4</sup> whose traces survive over much of the island, especially on the slopes of Kato Vardhia, and on those of Mt. Cynthos (which, with its temples, lies just outside the left margin of Plate 72).

A few words may be added on its history, for its bearing on other sites described in this chapter. The long early period of Athenian domination was followed by 150 years of independence which ended in 166 B.C., when, by a savage turn of fate, Delos became the victim of the rising ambition of Roman power politics. The inhabitants of the island were exiled, the authority of Athens was restored and Delos was made a 'free port'. The aim was to enhance Rome's commercial influence in the eastern Mediterranean, while also crippling the prosperity of Rhodes by causing her port-dues to slump. For eighty years more, Athenian settlers and Italian and Oriental traders built up a hectic prosperity (in which slave trading played an ugly part) before fate or retribution overtook them: In 88 B.C., Delos was sacked by Mithridates Eupator, King of Pontus. Damage was heavy but the Agora of the Italians and other buildings were restored. But it was again devastated in 69 B.C., by Athenodorus an ally of Pontus, and never recovered. Egypt and Syria were now trading directly with Italy, especially with Ostia. In the moribund remains of Delos only a few minor traders lingered on for small profits. In the 14th century there was a last twitch upon the thread: the Knights of St. John established an outpost, but later in the century the

<sup>1</sup> About 100 yards long. Mentioned as early as the time of Theognis (late 6th century B.C.), who called it the 'wheel-shaped lake'. On its waters swam the swans of Apollo. It has now been filled in to prevent malaria. Cp. W. A. Laidlaw, *A History of Delos*, 1933, p. 39.

<sup>2</sup> The area of the Sacred Harbour has been much diminished by soil dumped from the excavations, from which the tongue of land at right-angles to the shore was also formed. The original frontage inside this harbour is clear on Plate 72, as the long dark-toned line that delimits the temple area on its seaward side.

<sup>3</sup> For details, see 'Contributions à l'étude des ports antiques du monde grec' by J. Paris, *Bull. de Correspondence Hellénique*, 1915, 5-16; 1916, 5-73. The latter article contains excellent ground photographs of these eroded quays awash (esp. figs. 11 and 36).

<sup>4</sup> Cp. end-map in *Delos*, Vol. IV, pt. 1 (1911) for a ground survey of them, and figs. 57-8 and 107, for photographs. The cartographers experienced much difficulty with the confused rocky surface.



island was deserted. It was not many years, however, before the cartographer Buondelmonti and the antiquary Cyriac of Ancona were attracted to Delos, and the long cycle of archaeological discovery slowly and fumblingly began.

#### RHODES: DISCOVERY OF THE CLASSICAL STREET-PLAN

The islands of the Aegean, and the shores of S.W. Asia Minor in particular, offer great scope for aerial research and discovery on certain types of site (especially ancient cities and trading-stations) though little has yet been attempted and less published. I can only give one example, here, of the kind of detailed topographical study which is possible, and hope that it may help to pave the way for archaeological air-photography in this region, which is so urgently needed.

This example is based on photograph interpretation in conjunction with the study of maps and archaeological sources. It has revealed the elements of a street plan of Rhodes in Classical times, preserved in remains above ground, and not previously recognised as a whole when I made this discovery. In 1950 when assisting the President of Magdalen College, Oxford, Mr. T. S. R. Boase, to obtain a British war-time aerial view showing the medieval city, I was impressed by the traces of a regular layout inside and outside the city which had a common relationship. It was clear that these traces outside the medieval wall were more than rural boundaries in their origin.

The relevant data can be seen on Plates 73 and 74-5, and on Fig. 25. Before describing them, some preparatory attention must be given to the general setting and the history of the area.

At first glance, the eye is immediately held by the great girdle of ramparts built round the medieval town by the Knights of the Hospital of St. John of Jerusalem who, having left Acre in 1291, established their famous base at Rhodes from 1310 to 1522. Outside this fortress-town the countryside remained as Greek as ever. So much study has been devoted to Rhodes of the Knights<sup>1</sup> that a detailed description would be superfluous. Its defences were famous as a bulwark of Christendom in the later Middle Ages, and are renowned today as a uniquely well-preserved example of the military architecture of that period, with its rich array of medieval buildings for the Knights within. The immensely

<sup>1</sup> See, in particular, Albert Gabriel, *La Cité de Rhodes 1310-1522*, Paris, pt. i, 1921; pt. ii, 1923, and the volumes of *Clara Rhodos* (published by the Italian 'Istituto storico-archeologico di Rodi'), especially vol. i (1928). Gabriel, in his monumental study, notes that the Turkish captors were content to fill the breaches in the walls, and to clear out some of the ditches. 'Mais ils n'ont apporté aucune modification au tracé de l'enceinte, et la forteresse livre dans ses moindres détails le plan complet de ses défenses'. The long siege of Rhodes and its surrender in 1522 has been well described by Sir Charles Oman in *A History of the Art of War in the 16th century*, pp. 634-48. 'It was at this time probably the best fortified place in the world. . . . All the spare cash of the order, from all its commandaries round Europe, had gone into stone and mortar'. Living in constant fear of attack, the extremity of need in the final years had advanced its defences ahead of those in Europe, particularly with reference to artillery. It was only lack of casualty-replacements and gunpowder, which the Christian powers failed to send in time, that made it untenable.

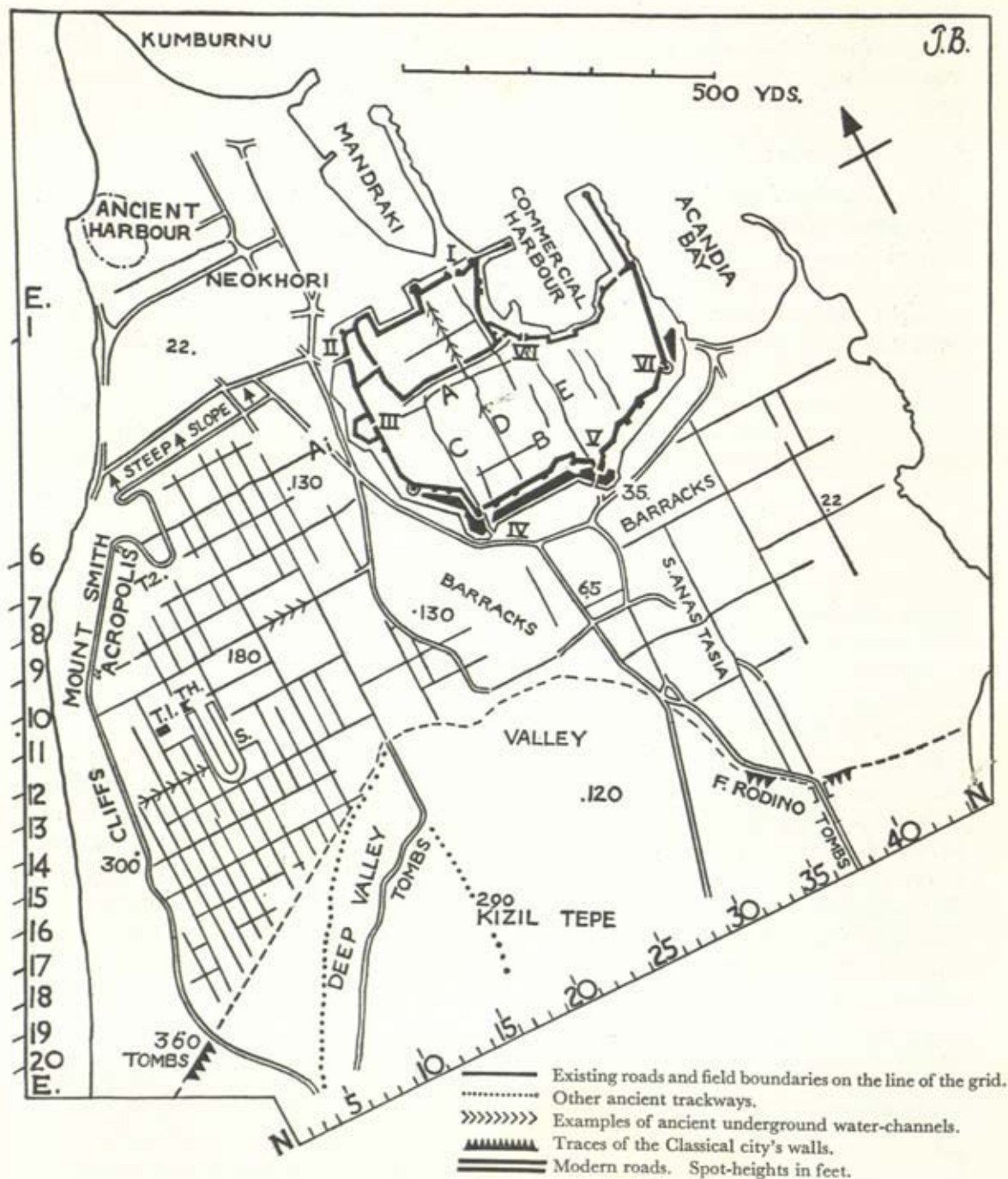
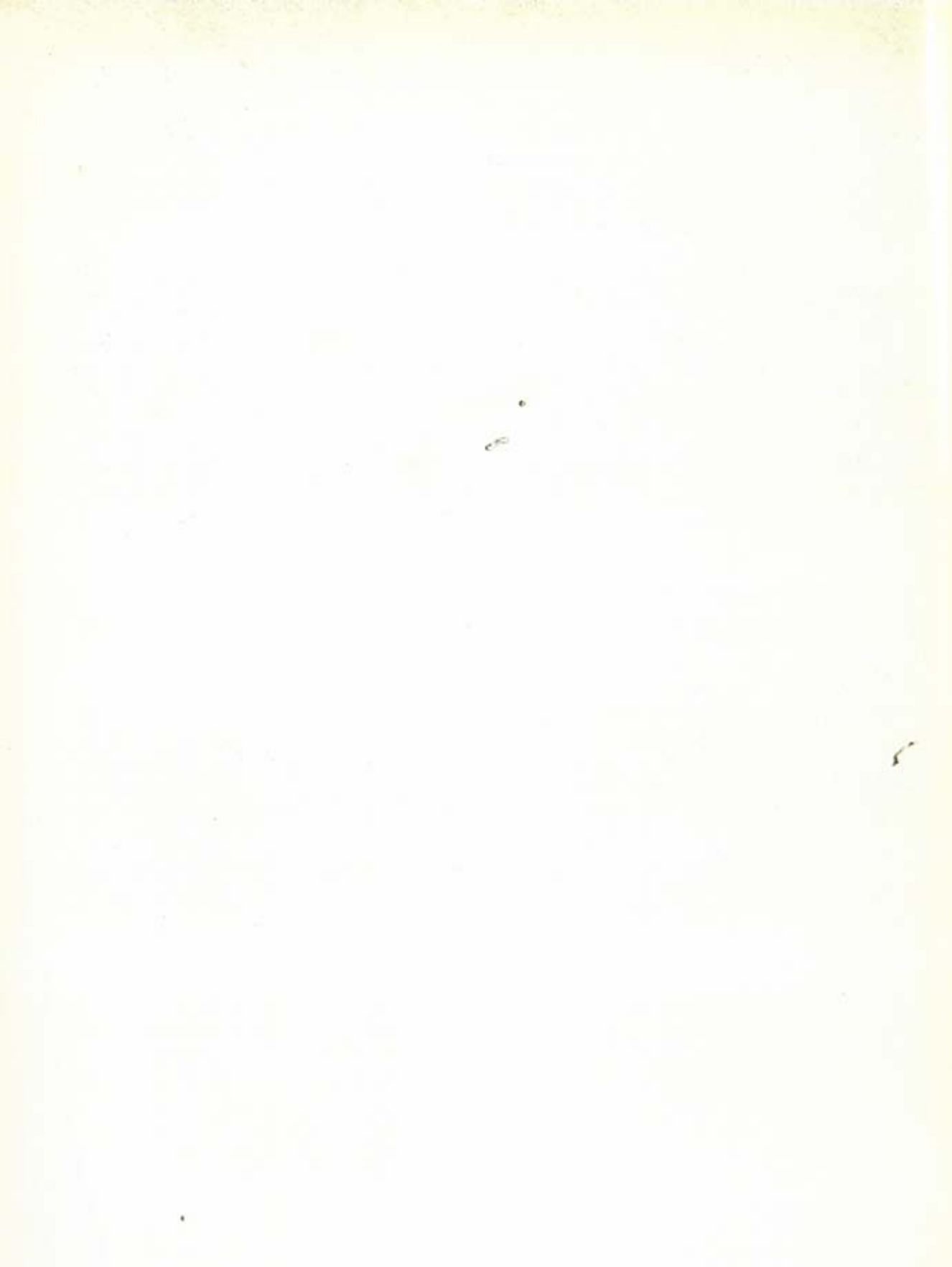


FIG. 25 Rhodes. The traces of the Classical town's gridded plan, mapped from data from air photos and from the ground. T.1 Temple of Apollo; Th. theatre; S Stadium; T.2 Temple of Athena and Zeus.





74. RHODES. Traces of Classical streets and a port. (a) *top left*. Looking east down 'Pindos Street' (=Fig. 25, Ai) from the upper end, to the ancient Agora and main harbour. On right: remains of ancient rock-cut side. (b) *bottom left*. Fosse and wall of the straight western side of the medieval defences, which correspond with a north-south line in the Classical grid. (c) *top right*. 'Agios Georgios Street' (looking north) on a north-south line in the grid, south of the existing city (=Fig. 25, N.40). (d) *bottom right*. A view north from the steep north side of Mount Smith; the position of the buried harbour occupies the open ground indicated. See p. 278. *Phs. Bradford*, 1955.







(a)



(c)



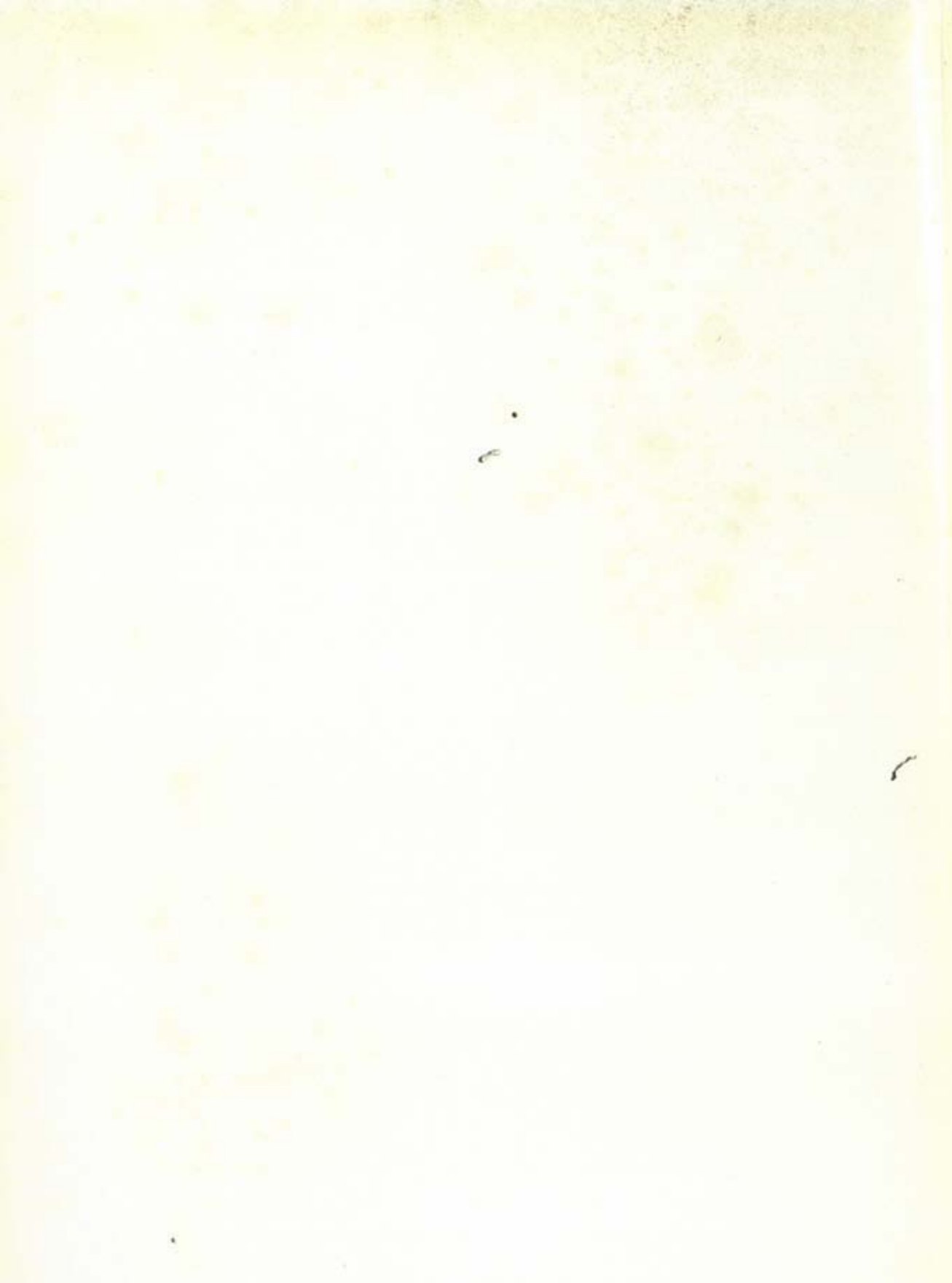
(b)



(d)

75. RHODES, MOUNT SMITH. (a) *top left*. A typical example of an old lane on the site of a Classical grid-line; this view is looking north along N.8 (see Fig. 25) south of the Stadium. (b) *bottom left*. 100 yards farther north on the same line, but looking south, showing the terraced profile typical of the N.-S. roads on Mount Smith, and also olive trees several centuries old on the same alignment. (c) *top right*. The Stadium, orientated with the grid, looking north to Admiral Smith's watch-tower on the skyline. (d) *bottom right*. A long rock-face cut and built, with Classical nymphaea, just south of the Temple of Apollo (in the background); its straight line corresponds with the east-west axis of the grid.

*Phs. Bradford, 1955.*





solid bastions, *fausses braies* in front, and the enormous rock-cut fosse (doubled in places) cut up to 40-60 feet deep and 90-140 feet wide, are not the kind of thing that fades away. The walls were less lofty than the old style, and were heavily gunned. The gateways, especially that named after the Grand-Master D'Amboise, are particularly impressive. The defence of the walls was apportioned so that each 'language-group' had its fixed sector.

In 1954 I reported my findings to the International Classical Conference at Copenhagen, and in 1955 I visited Rhodes in order to ground-check these discoveries and to discuss the problems with Mr. I. D. Kondis (the Ephor of Antiquities), whose excavations had led him to similar conclusions. I wish to express my thanks for his co-operation. Full details of my field-study of the traces of the Classical street-plan are given in *Antiquaries Journal*, 1956, 57-69, which also lists some essential references in the works of Aristotle, Strabo, Diodorus, Aelius Aristides, Eustathius, etc. To avoid duplication, the reader is also referred to this article for accounts of Mr. Kondis's excavations in recent years, of which some results have been announced in *Praktika*, the *Journal of Hellenic Studies*, etc. Proofs from excavation were, of course, essential. In summary, Mr. Kondis has recently found buildings and pottery on the lines of the grid which indicate an origin at least as early as the end of the 3rd century B.C., and these excavations have been carried out at points on both the north-south and the east-west axes.

When one measures the interval between the chief axial lines in the grid,—say for example among the ancient country lanes and field-boundaries on Mount Smith,—the rectangular units measure about 105 yards long by 55 yards wide. It seems possible that the unit of division was based on the *stadion*, but excavation must settle this problem. In some parts of the city Mr. Kondis has claimed evidence of smaller subdivisions 100 feet wide.

First, it is with the environs of the medieval town that we are concerned here. Today it is an area of vegetable gardens, with orchards, olives and age-old cultivation of an intensive kind,—essentially stable and conservative. In the Middle Ages it was the same. 'Tout autour de ladite ville beaucoup de jardins et tout plein de petites maisons, églises, et chapelles des Grecs'.<sup>1</sup> Félix Faber's description is even more explicit: *per circuitum urbis, in locis ubi mare muros non tangit, sunt horti et viridaria et pomeria qui irrigantur ex cisternis ibi fossis*.<sup>2</sup> Illustrations in certain late medieval sources indicate (though crudely) that all the surrounding area was covered with gardens and olive groves. It is in this setting that the parallel lines of an ancient system of roads or streets can be identified from the air,—as planned on Fig. 25. Some of these lines are preserved by existing roads which follow an ancient course, but most are represented by straight field-boundaries which can be just as adamant in preserving the line of ancient roads (as my examples of Roman centuriation in Chapter IV have already

<sup>1</sup> Thus Merri Dupui (writing between 1480-1522) quoted in Gabriel (*op. cit.*, pt. i, p. 15.)

<sup>2</sup> *Evagatorium in Terrae Sanctae Arabiae et Aegypti peregrinationes* (quoted in Gabriel).



proved). But before proceeding to the interesting conclusions to which the study of their layout leads us certain preliminary matters must be discussed.

First there are some important features of topography to be noted. West of the medieval town the ground is level but then slopes gently upward to Mount Smith<sup>1</sup> (80-110 metres) which runs parallel to the shore of the Bay of Trianda. Northward the expanding Greek and Italian suburb of Neokhori, on level ground, has obscured traces of ancient structures.<sup>2</sup> Beyond, the sandspit of Kumburnu would have been less extensive in the classical period. South of the medieval town, the ground outside stretches as a plateau as far as a deep valley that follows a sinuous course roughly from east to west across the neck of the peninsula and sharply defines and bounds the plateau. Southwards again, beyond this, the ground is much more broken and includes M. Mangavli (440 feet) and Kizil Tepe. The road and field patterns, there, are of irregular outlines adapted to contours, in striking contrast to those regular parallel lines across the site occupied by the classical city (which themselves are unparalleled elsewhere on the island).

Next, some matters concerning the history of classical Rhodes must be briefly summarised. From the united effort of three towns in the island it made its appearance in the Hellenic period in 408 B.C., as its new planned capital, becoming the chief city state in the Dodecanese. Traditionally<sup>3</sup> laid out by the great town-planner Hippodamus of Miletus, reputed for his work at the Piraeus, it has been described as more spacious than any Greek city except Syracuse and Athens, with 8 miles of landward walls. Professor Sir J. L. Myres commented<sup>4</sup> that 'it was heavily fortified landward far beyond the walls of the medieval city, with five wholly artificial harbours built in échelon with fine local masonry. . . . Of this splendid foundation, the ancient city of Rhodes,

<sup>1</sup> Named after Admiral Sir Sidney Smith who built an observation post on the summit in 1802 when the British fleet was engaged with the Napoleonic expedition to Egypt. The Mont St. Etienne of the Knights, and the Monte Stefano of the Italians. This hill has been described as the acropolis of the Greek city but there is no evidence of its separate fortification. It is more accurately termed the 'upper city'.

The roughly rectangular medieval citadel, on rising ground overlooking the ports, contained the Palace of the Grand Master. Gabriel, Maiuri and others, suggest evidence to show that the walls of this fortress at many points maintained the outline of a Hellenistic citadel, not yet proven.

<sup>2</sup> On the N.W. side of the peninsula are the outlines of an ancient harbourage, still preserved as a well-marked depression in the ground. For references from classical sources which bear on this, cp. Inglieri, *Carta Archeologica di Rodi*, p. 13. For a ground photo see my Plate 74d.

<sup>3</sup> But Haverfield (*Ancient Town-Planning*, 31-3), von Gerkan, and others have reminded us that there are good reasons for doubting that Hippodamus himself was its master-builder. The latest opinions are reviewed by R. E. Wycherley, *How the Greeks Built Cities*, 1949, 17.

The appearance of the city of Rhodes was compared by classical writers to a great theatre. But this would be naturally suggested by the shape of the enceinte, and by the general lie of the land when approaching port, with the arc of harbours in the foreground and the buildings rising up the slopes of Mount Smith behind. Wycherley rightly emphasised (p. 25) that this simile need not be taken to mean that the streets radiated from the Agora like the gangways of a theatre from an orchestra. The air photographs show no trace of any vestiges of radial planning on the ground.

<sup>4</sup> *Geographical History in Greek Lands*, 1953, 297-8. I should particularly like to record his kindly and helpful interest in the topographical study of the air photographic evidence.



almost nothing remains except the layout of three harbours, and even of these only two are now in use. Everything else has been obliterated by the vast fortifications of the Knights'. Stressing its wealth and importance, he added that in Roman times the island of Rhodes is estimated to have had a population of half a million (by a recent Italian estimate, in 1937, it was only c. 61,000). The city and its inhabitants were renowned for many reasons in classical times. Strabo, writing round about the last years of the 1st century B.C., recorded that 'it is so far superior to all others in harbours and roads and walls and improvements in general that I am unable to speak of any other city as almost equal to it, much less superior to it. It is remarkable also for its good order and for its careful attention to affairs of state in general'. Its symmetry and long, broad streets are mentioned by Aristides in the 2nd century A.D., and the great number of its statues by Pliny. Even today, monstrous size is still likened to the famous bronze Colossus, which from its position on the shore, was probably intended as a sea-mark. In short, the people of Rhodes had 'big ideas', but were famous for their love of good order, and maintained these characteristics for centuries<sup>1</sup> in the ancient world. It is important to keep these undoubted qualities in mind when shortly we consider its plan.

But subsequent centuries of spoliation, and shrinkage of population, have produced the paradox that even the outline of its landward wall is still a little uncertain in its detailed course, though its remains have been identified at several points,<sup>2</sup> which I have indicated on Fig. 25. The best modern authorities are in general agreement about the urban area enclosed and its great extent, much larger than that of the medieval city. Part of the S.W. salient of the city's wall has been excavated, on the projecting spur at the southern end of Mount Smith. From this point, its continuation north-east can be traced as a straight line which also forms the boundary of the gridded system of roads under discussion, and overlooks the ancient trackway from the coast which skirts it before bending north to enter the area of the ancient city. Part of the S.E. sector of the wall (and a tower) has been traced on either side of a bridge, of ancient origin, across the Fossato Rodino,—an arm of the steep-sided valley I mentioned earlier. In between these fixed points, local topography indicates an obvious course for the city's perimeter, i.e. following the north side of this west to east valley across the neck of the promontory. Significantly, this boundary also forms the limit of the area covered by the gridded system. The abrupt seaward scarp of Mount Smith gives a natural defence line on the west.

<sup>1</sup> Torr, *Rhodes in Ancient Times*, C.U.P., 1885, gives many examples of their notable combination of the old Doric severity and good sense, with an Oriental fondness for magnificence and ambitious projects on the grand scale. The latter quality manifested itself in all kinds of ways, e.g. the official support given to the spectacular plan to build a huge crane on the walls to grapple with and to lift over the great siege-engine of Demetrios.

<sup>2</sup> Cp. Maiuri in *Annuario della scuola arch. ital. di Atene*, III, 1921, 259-62; and in *Clara Rhodos*, vol. i, 1928, 44-6. Aristides imaginatively likens the city's walls to a diadem. The scarcity of surface remains is partly due to the Knights' haste to fortify their new home, for which they doubtless re-used any surviving ancient masonry that was suitable.



It is known that the city's buildings were very badly damaged by earthquake in c. 225 B.C. It was restored with the help of contributions sent from all over the Greek world. Whether this would have destroyed the whole street plan, or could have occasioned a decision to lay out an entirely fresh one for the whole city is not certain. Another notable rebuilding was that by the Emperor Antoninus Pius, after the destruction caused by the earthquake and tidal wave c. 157 A.D., but this should not have changed the street-plan of the city as a whole.

We cannot here follow its history step by step, but it enjoyed a good measure of prosperity and some little power under the Roman Empire, though certainly less than in its greatest days in the 4th to 2nd centuries B.C. Earthquakes also struck the city in A.D. 155, 575 and c. 650, but the rise of Islam and Saracenic sea power contributed much more to its decline. The freedom of the seas meant everything to Rhodes. Its importance was that of a free port in an organised Mediterranean world. The probable condition of Hong Kong after a period of prolonged anarchy in the China seas would suggest a parallel from our own time. In its eclipse, the city area shrank and shrank towards the ports that were its heart. (Note the silted harbour on the N.W., see Fig. 25 and Pl. 75.)

We may now marshal some of the new evidence from the ancient street-plan, as indicated from the air photographs (Plate 73 and Fig. 25) and supported by ground photographs (Pls. 74-5).

The prime value of the air photographs lies in showing the exact and full details of the relationship shared by many of the existing minor roads<sup>1</sup> and field boundaries. A clear and coherent pattern of parallel lines, intersecting at right angles, can now be distinguished. This can be traced right across the width of the peninsula, with an occasional hiatus<sup>2</sup> due to later disturbance

<sup>1</sup> In the 1920's and 1930's the Italians built several straight roads, south of the medieval city. A few sectors of these were set out parallel with those of ancient origin. As in Roman centuriation, ancient straight lines give rise to other modern ones. But the latter are easy to identify and to eliminate, after reference to 19th century maps. Compare, for example, the map in Hiller von Gaertringen, *Inscriptiones Graecae Insularum*, 1895, XII, 1, pl. II.

<sup>2</sup> The lines of the grid are best preserved where farther away from the medieval town. This is natural, for, in addition to modern Italian buildings (barracks, etc.) outside its walls, there grew up since 1522 a broad belt of Turkish and Jewish cemeteries round the town. The barracks-area has caused a big gap in the ancient boundaries.

But it is interesting to note that the area containing that part of the ancient street-grid between Mount Smith and the medieval town recently had the Turkish name *Docuz Socak*, i.e. 'nine streets' (*socak* means true streets, not paths). 'Nine' may be generalised to indicate a large number. However, it is clear that the Turks clearly recognised the unusual topographical importance of the road-net in this area, and perhaps preserved an earlier name. The grid of roads and regular internal subdivisions were certainly not inspired by the Turks. Newton in 1853 tells how they had been content to leave a fallen medieval tower that blocked a main street of the town. Not a stone was touched. A major replanning of the landscape would not have appealed to them.

It should be noted that the three big villages outside the town to the south, which sprang up immediately after 1522 for the remaining Christians (who had to leave the town at sunset) have preserved, as their main streets, certain roads belonging to the ancient grid which were evidently in medieval use (e.g. Plate 74c).



exactly as in all ancient layouts on a large scale (e.g. in centuriated field systems). But the way in which the alignment continues again is very significant. On the ground, of course, it is 'close country', with the orchards and scattered houses restricting visibility to close range. It is true that at eye-level 'one cannot see the wood for the trees', or form a clear idea of the regularity of the layout that can in fact be traced. This was reflected in the recent maps. Thus the Italian large-scale<sup>1</sup> maps omitted many of the minor field-boundaries, which are so important for this kind of study, or often show their position very schematically. Even the roads are not without small errors in their alignment, due to excessively conventionalising their course in drawing the map. Vertical air photographs are more accurate than most large-scale maps, as they show everything *as it is*, without interposing the simplifications and omissions inherent in much cartography (especially if air survey is not used to control the map-making).

One axis of this system runs exactly North to South, and the other East to West. We are not dealing with the remains of a rural landscape, as in the systems of Roman centuriation described in Chapter IV, nor with ordinary cultivation-terracing, but, quite certainly, with the surviving elements of an urban street-plan. No other conclusion seems tenable in the light of the evidence. The area covered is certainly large, but the site demands a large city,<sup>2</sup> for the only perimeter was the defensible valley across the peninsula. At all points, this rectilinear system at Rhodes lies with notable exactness within the circuit which the classical city wall is believed to have followed inland, and which at several points can be shown to be the system's boundary. One is at the S.W. corner of the system where it runs up to a sector of the wall which has been excavated. As long ago as 1853, Newton, during his exploration of the zone between Mount Smith and the medieval city, had called attention to some of the west-east roads shown on my map, and noted that they were partly rock-cut and ancient. Sir John Myres, Professor Maiuri, and others,<sup>3</sup> have also remarked on these deep cuttings. 'Everywhere I met with inscribed altars and bases of statues, and fragments of architecture', wrote Newton of this area. But the ground was 'so intersected with the walls of fields and gardens that it is exceedingly difficult to discern the vestiges of the ancient city; still more so to indicate their position in such a manner as to enable subsequent travellers to find them'.<sup>4</sup>

Some evidence for the date of the rectilinear system is also given by the

<sup>1</sup> E.g., see end-map in *Clara Rhodos*, vol. i, 1928; and R. V. Inglieri's *Carta Archeologica di Rodi*, 1936. These are only photographic enlargements of the 1 : 50,000 maps.

<sup>2</sup> Many maritime cities of the period had a similar problem. At Syracuse, for example, there was the difficulty over how much of the embarrassingly long plateau of the upper town behind the ports should be enclosed by walls. Eventually, and inevitably, the defences had to be extended far inland to the plateau's narrowest point, where Dionysius I built the fortress of Euryelos c. 400 B.C.

<sup>3</sup> E.g., Erdmann, in *Philologus*, XLII, 1884, 223-4, in his article on Hippodamus.

<sup>4</sup> (Sir) C. T. Newton, *Travels and Discoveries in the Levant*, 1865, vol. i, p. 166. His very lively and observant account gives a valuable picture of the local scene in 1853, when he was Vice-Consul at Mytilene. By 1865 he had become Keeper of the Greek and Roman Antiquities, British Museum.



alignment of the ancient subterranean aqueducts along the axes of its west-east roads (see Fig. 25) descending from Mount Smith. Rhodes is famous for these *gallerie*, excavated to a great depth in the rock and assigned by Inglieri (*op. cit.*, p. 18, No. 23) to the 3rd to 1st centuries B.C. Their lines coincide with the gridded layout as if the latter already existed. This general indication of date is strengthened by the siting of the Stadium in part excavated, and dated as probably not earlier than 2nd century B.C., by Maiuri). Its alignment exactly follows the N.-S. and E.-W. axes of the gridded system, but, in relation to the street-plan as a whole, the position of the Stadium suggests that of a later interpolation.

It is the west-east lines that are the best preserved, and a number of them can be traced right across the peninsula, in spite of the breaks which modern buildings have caused in the minor roads and field boundaries which preserved the ancient lines. Those on the slopes of Mount Smith are particularly clear. One of these ancient streets is represented by the suburban lane now named Pindos Street (see Fig. 25, A. i; and Plate 74a). As long ago as 1853 Newton suggested that an ancient rock-cut street had run on this line, and Mr. Kondis has recently confirmed by excavation that certainly it was in use in Hellenistic times. It led from the site of the temple of Athena Polias and Zeus Polieus on Mount Smith down to the principal gate of the Commercial Harbour.

The north to south parallel lines are also made up of minor roads and property-boundaries. Most of them have very old trees along them (Pl. 75b). Ancient streets on this axis, themselves naturally worn or cut in the rock, would have made convenient boundaries for cultivation in later times, and low terraces would form. Such usefulness would be a stabilising and preserving factor. But it should be emphasised that these north-south lines occur on level ground also<sup>1</sup>, and therefore cannot be explained by cultivation-terracing alone.<sup>2</sup>

In all these lines there has been a tendency to shift a little to one side or the other of a straight line, which is natural when field-boundary walls are remade or roads are repaired in later periods. This characteristic is also frequently found in the surviving traces of Roman fields laid out by 'centuriation'. In such cases it is always advisable to measure the mean average of several of the units of partition, rather than expecting every single one to exhibit the ideal measurements.

One major point, of importance but some difficulty, remains to be considered. It has been thought by many that certain streets *inside* the medieval town were on the line of those in antiquity, in spite of the maze of little streets which meets

<sup>1</sup> Note an important detail:—on the part of the photo which covers the area east of the village of S. Anastasia the N.-S. lines of roads appear to be very slightly further apart than are those on the slopes of M. Smith. The explanation is to be found in the ordinary principles of surface geometry. The former are on level ground and the distance between them will naturally appear a little greater than will the same distance down a slope, when planned vertically from above. The distance between the E.-W. lines, *along* the hillside, is naturally unaffected by this and is exactly the same on level ground as one would expect.

<sup>2</sup> One comparison is the excavated plan of the town on the North Hill at Olynthus, which was destroyed in 348 B.C. The street-grid was divided into numerous regular rectangles, c. 99 × 44 yards (measured from mid-street to mid-street). Cp. D. M. Robinson, *Excavations at Olynthus*, Vol. XII, plate 271, streets I-XIII.



the eye at first glance. Finds made during occasional deep digging in the city have supported this view.<sup>1</sup>

It is, beyond doubt, significant that the main streets of the medieval town do not fan out from the harbour to the gates, but instead conserve the time-worn remains of an earlier criss-cross pattern with axes at right angles. These traces are fewest among the alleys, in the eastern third of the town,—the Jewish quarter in recent times. Gabriel (*op. cit.*, p. 11) wrote 'tout au plus, peut-on supposer que ces directions nord-sud et est-ouest, qui dominent aujourd'hui, étaient les deux axes rectangulaires suivant lesquels s'orientaient les rues de la ville hellénique'. In this matter, great caution and care are called for. But two new points deserve to be mentioned. One is that air photography shows that there are several long lengths of street in the medieval town which are very much straighter than one would believe from their schematised course on maps.

The other point follows from the last, and has an important bearing on the whole problem of the Classical city's plan. With the air photograph in front of us, giving an exact vertical plan-view, we can see clearly how several of the straight stretches<sup>2</sup> of streets *inside* the walls are on the same alignment as those in the grid of lines *outside* the walls, and run in harmony with both the west-east and the north-south lines which I have mapped.

Let us take the ancient west to east roads first. One (Fig. 25, Ai) of these occupies a very significant position. When the Knights built their fortifications it must have passed into the city via the St. George Gate (Fig. 25, III), which was later closed by a bastion in front.

At first glance it seems difficult to decide which of two existing east-west streets south of the medieval citadel preserved the Classical alignment. The correct answer is:—both of them.

For, this was the medieval market-place, a long, straight and broad thoroughfare<sup>3</sup> outside and parallel with the south wall of the citadel. This 'piazza' can be seen on a miniature in Caoursin's MS., reproduced by Gabriel; it was of cardinal importance throughout the Middle Ages, even though shops gradually encroached on it in the 15th century, as pressure on space inside the walls increased. Since Turkish times it has been covered by buildings. It was the largest open space in the medieval city, and may well have inherited the position of the Agora of Classical Rhodes.

Further south inside the walled city there is another straight street (B) which runs west-east, and lies exactly on the continuation of the line of one of the west-east lanes outside the walls.

<sup>1</sup> Cp. Inglieri (*op. cit.*, p. 15, No. 11, with references) for traces of the Classical city below the Medieval one.

<sup>2</sup> Noticeably straight, that is, for Rhodes! Maiuri, in his book *Rodi*, 1921, 33, 35-6, had pointed out that there were some ancient parallel roads on the slope of Mount Smith, regularly spaced; and suggested that one of these continued the line of the 'Street of the Knights' (inside the citadel) up to Mount Smith. He did not, however, map or describe the other street alignments which continue across the medieval ramparts.

<sup>3</sup> The exit for this main thoroughfare was the Porta Marina, the great principal gateway from the 'Commercial Harbour'. Up to the end of the 19th century it opened straight on to a sandy beach. The existing gate was built in 1478, but replaced an older one (Gabriel, *op. cit.*, 25).



Taking, next, the north to south streets inside the walled town which accord with the grid outside, we notice four which are relatively straight (C to E). It is not to be expected that they should be mathematically straight, after all that has gone on in the teeming built-up area, but they are noticeably straight compared with all else, and this is not accidental. If one measures from the nearest north to south lines outside the walls, it will be found that in fact they correspond with the units of division outside. Thus a distance equal to the widths of 10 of the rectangles of subdivision takes one to street C, the width of 3 more to street D, and the width of 4 more to street E. Naturally we cannot explain the vagaries of fortune that have caused these north-south streets to survive and not others.

It is interesting, too, to note that the two most obviously straight sectors of the medieval walls also fall into place in the grid. On the south side, the long west-east sector from the St. Athenasius Gate (No. IV) is in continuation of a major ancient west-east road down from Monte Smith. And, likewise the straight sector containing the St. George Gate fits well with the north-south axis. There is no reason why a pre-existing road should not have been used for convenience in sighting the line for parts of the medieval enceinte.

There is one further point to be mentioned. If the medieval ramparts were constructed across the lines of streets of ancient origin that had previously run continuously from the present built-up area out into the environs, it would be natural to find the medieval gates sited on such lines, which would form part of the grid. This actually seems to have happened. The positions of the St. Antony Gate (II), the St. George Gate, the St. Athenasius Gate, the Koskino Gate (V), and the Gate of Italy (VI), agree with the suggestion that their siting was occasioned by desire to give passage to pre-existing roads which occupied positions determined by the regular spacing in the ancient grid-system. In some cases these gates were later blocked up,<sup>1</sup> and the road outside was liable to wither.

All these correspondences of detail, considered collectively, are more than can be explained by coincidence. Taken together, they provide a valid reconstruction of the elements of the street-grid. The details of this layout could not have been established from the Classical texts, but only by field-archaeology.

The results of the recent excavations go to support the views I have set out on the wider issue of the ancient town-plan considered as a whole. It will scarcely be necessary to draw attention to the physical parallel with the peninsula covered by a gridded street-plan at Miletus,<sup>2</sup> which was the native town of Hippodamus himself. At Rhodes the essential problem now is the date of *origin* of the grid. In *Antiq. Journ.*, 1956, I summarised the latest excavated evidence.

<sup>1</sup> The St. Antony Gate was one of the exterior gates of the town as late as 1460, but became a mere interior postern in the last period of fortification, when the suppression of the St. George Gate, the St. Athenasius Gate and the Gate of Italy was also decided. The positions of the latter three gates agree well with the units of spacing between the N.-S. lines. In naming the gates I follow Gabriel.

<sup>2</sup> Cp. plans by von Gerkan, *Griechische Städteanlagen*, and by Wiegand.



## INDEX





# INDEX

*References in footnotes are listed under the page-numbers on which the notes occur*

- Adam, Robert 186  
 Aden 80  
 Aelius Aristides 279, 281  
 Aerial demonstrations, technique of x  
 Aerofilms Limited xi, 66  
 Africa, air archaeology in  
     Sec:—Algeria, Centuriation, Cyrenaica,  
           Egypt, Fezzan, Kenya, Rhodesia, Trans-  
           vaal, Tunisia, Uganda  
 Aggenius Urbicus 152  
 Agrimensores 76, 149-52, 161-9, 188, 195, 212-14,  
     Fig. 12  
 Air Archaeology (selected references):—  
     Aims and Objectives viii, 1, 3 seq., 11 seq.,  
     49 seq., 75 seq., 83-4, 103-4, 112-14, 148,  
     155, 217  
     Air Crew 56-7, 91  
     Air Survey of ancient cities, etc. 63-74  
     Anaglyphs 61  
     'Buried Landscapes', definition of viii, 5, 88  
     (see also Apulia, Etruria, Great Britain,  
     Tunisia, passim)  
     Comparative Coverage 92, 124, 126, 137,  
     142, 180, 189, Pls. 33 a, b  
     Continuous-strip photography 59  
     Crop-marks Argentine 14, Balkans 78-9,  
     Belgium 76, France 14, 75-6, Great Britain  
     13-24, 28, 75, 84, Pls. 1-4, Greece 45, 78,  
     275, Pl. 13, Italy 5, 14-15, 19-20, 34, 77,  
     88-105, 113 seq., 119 seq., 148, 156, 225,  
     242, Pls. 25-8, 30-1, Kenya 24, U.S.A. 24,  
     80-1  
     Damp-marks 28-9  
     Filters 42-3, 55-6  
     Grass, vegetation, and weed marks Africa  
     26-7, Great Britain 19-20, 24-5, Italy 20,  
     25, 90, 115, 119 seq., 127 seq., 222 seq.,  
     Persia 26, Russia 82, South-east Asia 24,  
     26, Syria 26, Tunisia 197, 204-5  
     Ground-checking and excavation, essential to  
     Air Archaeology viii, examples: Apulia 86,  
     93, 97, 103, Attica 29, 33-4, Pls. 9-10,  
     Etruria 119, 130, 140, 144, Pls. 29 b, 31 b,  
     32 b, 35, Great Britain Pls. 1-2, Le Motte  
     Pl. 67, Ostia 238, 242, 248, Pl. 61, Paestum  
     222, Pl. 53, Rhodes 279, Pls. 74-5, Roman  
     Centuriation (Europe and Tunisia) 206,  
     215-16  
     Infra-red and colour photography 43, 55-6,  
     124  
     Interpretation of air photos, examples 2-3,  
     11 seq., 62, 115, 180-2, 'First Phase' inter-  
     pretation 85, 92 (see also Sources of Error,  
     Stereoscopy, Terrain-Appreciation, etc.)  
     Levelling from air photos, for archaeological  
     survey 65-6  
     Oblique photography, technique 11, 15, 17,  
     22, 47, 50-2, 'High-level', and 'Twin  
     low-obliques' 53  
     Origins of Air Archaeology 8, 14, 23, 52  
     Parch-marks Great Britain 14-15, 19-21, 23-4,  
     Indo-China (Saigon) 26, Italy 20, 25, 115  
     Photogrammetric Tables 58  
     Photogrammetry, methods and machines,  
     archaeological use of 64-6  
     Photographic apparatus 43, 54 seq. (see also  
     Obliques, Verticals, etc.)  
     Polarised viewing-spectacles 61-2  
     'Plotting' air photos 53, 61, 63-6, 92, Figs. 3-4  
     Publication of air photos 9-10, 57, 63, 79, 83,  
     93  
     Recent aerial discoveries in Mediterranean  
     lands 6 seq. (see also Arpi, Cuneo, Meta-  
     pontum)  
     Scope and limitations of search ix, 2, 5,  
     11 seq., 40, 75-84, 103-4, 143, 232, 275 and  
     passim  
     Shadow-sites and earthworks, examples of  
     Algeria 40, Balkans 78, Denmark 35, Eire  
     35, Great Britain 12, 34-9, 74, Pl. 11,  
     Greece 32, Iraq 24, 68, 73, Pls. 17-19,  
     Israel 74, Italy 250 seq., Pls. 60-1, 268 seq.,  
     Pls. 66-7, Persia 40, 69, Pl. 20, Spain 39,  
     Syria 63, 83, Russia 81-2, South (and  
     Central) America 14, 80, U.S.A. 80-1  
     Snow-marks 44, Pl. 12  
     Soil-marks Actual formation of 28, Pl. 5,  
     Algeria 40, Anatolia 71, Dalmatia 180,  
     Great Britain 27-9, Greece 29-34, Pls. 6-10,  
     Italy 27, 32-3, 52, 59-60, 115, 124, 127-9,  
     135 seq., 140 seq., 222 seq., 242, Pls. 32 b,  
     33, 36, 37, 59-60, Syria 40, Tunisia 197

Air Archaeology—*continued*

- Sources of Error in Photo Interpretation 10, 22, 47-9, 154, Pls. 14-15
- Stereoscopy, essential importance to archaeology 59-63, 66, 92, 94, 115, 227, 241, 254, Pls. 15-16
- Terrain, appreciation of 11 seq., 44 seq.; examples: Apulia 88-9, 92, 94, Etruria 132, Ostia 238 seq., 243, 247 seq., 253 seq.
- 'Total Mapping', archaeological purpose of 2, 12; examples: Africa, Asia 79 seq., Dalmatia 179 seq., 184 seq., Great Britain (see under Scotland, East England, and Celtic Fields), Greece Pl. 6, Iraq 53, 73, Pl. 24, Istria 176 seq., Italy 61, 92, 111, 114, 119, 127, 137, 141, 146-8, 155-6, 159-60, 170 seq., 212-13, Pls. 36, 38, 52, Rhodes 277 seq., Pl. 73, Syria 83, Town Planning 216, Tunisia 193-206, Pl. 49
- Underwater sites, photography of 41-3
- 'Vectographs', stereoscopic lantern slides 61-2
- Vertical photography, general 8-11, 22, 54, 58, Measurements calculated from (examples) 57-8, 63, 92, 99-102, 114, 126, 130, 137, 143, 183, 191, Photographic coverage, calculation of 59, Photographic scales and their archaeological potentialities 46, 57-9, 66-7, 71, 91, 113 seq., 121, 'Split verticals' 62, 91
- Visual air reconnaissance 44-7, 50, 56, 91 (see Obliques, etc.)
- World air-photo coverage 79
- Air Ministry (London) vii, xi, 8
- Air Ministry (Rome) x
- Algeria, Roman viii, 10, 40, 58, 147
- Allen, G. W. G. vii, 4, 15-16, 18, 22, 28-9, 37-9, 43, 51, 54-5, 84, 146
- Altinum, see Centuriation
- America, air archaeology in  
Central and South 14, 80  
North 80-1
- Ammianus Marcellinus 72, 253
- Anatolia, air archaeology in 5, 66, 69-71, 108, Pls. 21-3
- Andrae, W. 72-4
- Anzio 41
- Apollonia 41
- Appian 233-5
- Apulia, Foggia Plain, aerial discoveries 7, 56, Medieval viii, 12, 36, 86, 89, 270, 273  
Neolithic viii, 85-110, Fig. 5, Pls. 25-8  
200 buried settlements, unique importance of discovery 88, 98  
Aerial methods used in 1945 85, 91 seq.  
Context and distribution of sites 88, 97-8, 102-4
- Detailed report in preparation on excavations 86, 93, 95, 97, 99, 103
- Interim reports 86, 93
- Internal planning, enclosures ('compounds') 96, 100, 102
- Size and status of sites 94-5, 99-104
- Voyaging 105-10
- Roman 86 (see also Centuriation)
- See also Arpi
- Aquileia see Centuriation
- Aristotle 279
- Arpi, Apulia, air discoveries at 217
- Asil, Naji al 72
- Atkinson, R. J. C. 18, 25
- Attica (see also Hymettos) 29, 31, 34
- Australia, air archaeology in 46
- Baker, A. W. 54
- Balkans, air archaeology in 78-9, 270
- Baradez, J. viii, 7, 10, 40, 58, 83, 146-7
- Barocelli, P. xi, 91
- Barthel, W. 193, 198, 200-1, 206
- Bartoccini, R. 111
- Beaumont, R. L. 192
- Belgium, air archaeology in 76
- Beresford, M. 8, 25, 36
- Bersu, G. 24
- Blanc, A. 208
- Boase, T. S. R. 277
- Boëthius, Axel xi, 220, 225
- Bomford, Brigadier xi
- Bonaparte, Lucien 134
- Bradford Abbas, Dorset Fig. 3
- Brea, Bernabò 103, 109, 110
- British Academy x, 93
- Brogan, Mrs. O. 264
- Broughton, T. R. S. 193
- Brown, F. E. xi, 226-31
- Buck, Sir Peter 107
- Burial mounds 8, 16, 23, 27, 39, 75, 76, 84 (see also Gordion and Etruria)
- Caillemer, A. xi, 197, 204-5
- Calza, G. 239, 242, 245-6, 248, 251, 255
- Campanari, collector of Etruscan antiquities 134
- Canada, gridded landscapes in 154
- Cantley, Roman farm, 17, Pl. 3
- Capaccio Vecchio, near Paestum 218, 221
- Capri, neolithic 105
- Capua, see Centuriation
- Carabelli, E. 114-15
- Carcassonne 265-6, Pl. 70
- Carcopino, J. 197, 252
- Carta Rateriana 259-60
- Carthage, air archaeology at 7, 146, 169, 193, 197-201, 226, 231-7, Pls. 48, 56



- Cary, M. 162  
 Casson, Stanley 178, 192  
 Castagnoli, F. 152, 166, 191, 212, 228  
 Castelfranco Veneto 267-9, Pl. 65 a  
 Castor, Roman roads near, see Durobrivae  
 Caterini, R. De 151  
 Catling, H. W. ix  
 Cato 163, 165  
 Caton-Thompson, G. 26, 47  
 'Celtic fields' 8, 18, 29, 34-5, 37-8, 44, 51, 59, 63, 76, 84, 147  
 Centocelle near Rome 20  
 Centuriation:—  
   Alba Fucens 166  
   Altinum 156, 166-9, Pl. 39  
   Apulia viii, 19-20, 25-6, 30, 58, 61, 90, 148, 152, 156, 166, 175, 195, 202, 204, 211, 214-15 (for references to Reports 86, 93)  
   Aquileia 7, 167, 170-4, 215  
   Asolo (Acelum) 149, 168-9, 268  
   Bassano 160, 168-9  
   Bologna 157, 162  
   Capua 150-1, 166  
   Carthage 146, 169, 193, 197-201, 231-7, Pl. 48  
   Centuriation used for administration or taxation 145-6, 149, 152, 153, 195  
   Cesena 7, 145, 155-65, Fig. 13, Pl. 38  
   Concordia 167  
   Corinth 214  
   Cosa 166, 228  
   Cremona 169, 262  
   Cuneo 155  
   Cyprus 214  
   Cyrenaica 214  
   Djebeniana 204, 206  
   England 215  
   Florence 151, 155, 159, 166, 168, 191  
   Forum Iulii (Cividale) 172, 174  
   Forum Popili 145, 157, 159  
   Gemonia 170, 172, 174  
   Germany 213, 215  
   Haïdra (Ammaedara) 205-6  
   Hvar 151, 156, 183, 191-3, Fig. 18, Pl. 47  
   Ivrea 149, 151  
   Lodi 155  
   Lucca 166, 259  
   Lucera 166  
   Luna 166, 174  
   Modena 157, 262  
   Orange 210-11  
   Ortona 166  
   Padua 160, 168-9, Pl. 39  
   Pannonia 214  
   Parenzo 176  
   Parma 157  
   Pavia 149, 263  
   Piacenza 153, 262-3  
   Pisa 149, 151, 191  
   Pola 7, 151, 155, 175-8, Pls. 40-1  
   Po Valley 149, 151, 153-66  
   Provence 211  
   Salona 150, 156, 183-93, Fig. 17, Pls. 44-6  
   Saturnia 157  
   Sousse-Chebbia 200-6, Pl. 49  
   Spain 76-7  
   Switzerland 215  
   Terracina 165  
   Tortona 155  
   Treviso 167  
   Tricesimo 170-4, Fig. 14  
   Trogir 184, 188-90, Pl. 46  
   Troia 166  
   Tunisia 148-9, 153-4, 168, 188, 193-207, Fig. 19, Pls. 48-9 (see also Carthage)  
   Ugljan 156, 183, Fig. 15  
   Valence 7, 146, 207-11, Fig. 20, Pls. 50-1  
   Voghera 155  
   Zara 149-50, 156, 178-83, 187, Figs. 15-16, Pls. 42-3  
 See also:—  
   Agrimensores, see index  
   Centuriation, origins of 166  
   Excavation, essential 206, 215-16  
   Limites intercisivi 153, 155-6, 159-62, 168-9, 177, 182, 187-8, 194, 200-2, 205, 212 seq., Fig. 16, Pls. 39-43, 47-49  
   Scamna-Strigae 163, 201, 212-13, 243  
   Un-centuriated systems contrasted 77, 146-8, 162, 163, 190, and Algeria, Great Britain, Roman Villas, etc.  
   Vine-trenches and tree-pits 15, 19, 25, 58, 194, 204  
 Cerveteri, aerial discoveries at, Banditaccia 13, 111-26, 143, Figs. 6, 8, Pls. 29-32a, Monte Abetone (or Abbatone) 127-31, 143, Figs. 6, 9, Pls. 34-5  
 Cesena, see Centuriation  
 Charlesworth, M. P. 178  
 Childe, V. G. xi, 98, 106, 108, 109  
 Chilver, G. E. F. xi, 162-3  
 Cittadella 267, Pl. 65 b  
 Civitavecchia 255  
 Claeys, J. Y. 46  
 Clark, J. G. D. 3, 28, 37, 106  
 Clausen, R. 211  
 Colle Pantano (Etruria), aerial discoveries at 27, 139-43, Fig. 11, Pls. 32 b, 33  
 Columella 162-3  
 Coppa Nevigata, Apulia 104  
 Cordingley, R. 188  
 Cosa 166, 226-31, Pls. 54-5

- Cousteau, Commander 43  
 Craven Committee, Oxford x, 93  
 Crawford, O. G. S. vii, xi, 8, 13-14, 16, 24, 27-8, 29, 34, 36-8, 45-6, 52-5, 59, 78-80, 84  
 Crete 107-9  
 Cuneo, N.W. Italy, Centuriation mapped from air photos 155  
 'Cursus' sites 18, 23  
 Curwen, E. C. 38  
 Cyprus, air archaeology in ix, 44, 107-9, 214  
 Cyrenaica 44, 109, 146, 214
- Dacia 78  
 Dalmatia 12, 76, 164 (see also Hvar, Ragusa, Šolta, Salona, Ugljan and Zara)  
 Daniel, G. E. xi, 8, 61  
 De Bon, A. 169  
 Degrassi, A. 172, 175-6  
 Degrassi, N. xi  
 Delhi 52  
 Della Corte, M. 151  
 Delos 274-7, Pl. 72  
 Denmark, air archaeology in 7, 13, 35, 76, 147  
 Dennis, George 116, 118, 131, 132-4, 231  
 Deserted medieval villages (Britain) 25, 36, 90; (Italy) 36, 231  
 Dickinson, R. E. 217  
 Dikaios, P. 108  
 Dinsmoor, W. B. 222  
 Dio Cassius 72, 250-1  
 Diocletian, Emperor 153, 184-6  
 Directorate of Colonial Survey, British 9  
 Direzione Generale delle Antichità e Belle Arti, Rome xi  
 Djebebiana, Tunisia, see Centuriation  
 Dorchester, Oxfordshire 14-15, 17, 23, 25, 38, Pl. 1  
 Drago, C. xi, 98  
 Drewe, C. D. 37  
 Drilling, new explorations of Etruscan tombs 114, 144  
 Dunbabin, T. J. xi, 29, 220  
 Dunluce, N. Ireland, 35, Pl. 11  
 Dürer, A. 270  
 Durobrivae (Castor), Northants 20-2, 47, Fig. 1, Pl. 4 b  
 Dyggve, E. xi, 183-6, 189
- Egypt, air archaeology in 26, 46, 47, 80  
 Eire, air archaeology in 35  
 Electrical Resistivity Survey 13, 115, 144  
 Eliot, C. W. T. xi, 29  
 Erbil, Iraq 62, Pl. 16  
 Erosion, soil 32, 203  
 Etruria, aerial discoveries in  
 2,000 levelled tumuli mapped 111 seq.  
 Technique 113-15, 119, 142-3
- Buried roads located in cemeteries 114, 119-22, 127-30, 138-9, 142  
 See under:—Cerveteri (Banditaccia and M. Abetone), Colle Pantano, Tarquinia; also Veii, Vulci (roads to cities); for electrical resistivity surveying, drilling, and periscope photography of tombs 13, 114-15, 144  
 Euesperides, site of, Cyrenaica 44  
 Europe, Central, air archaeology of 45, 48, 78, 154, 214, 270  
 Eustathius 279  
 Evans, J. D. 109  
 Evans, Sir Arthur 108, 110  
 Ewald, E. 16  
 Ewins, U. 172  
 Eynsham, Oxon. 16, Pl. 2 a
- Falbe, C. T. 198, 232, 234-5  
 Fayum, Egypt 26, 47  
 Fezzan, Libya 80  
 Field-shape and land-form 45  
 Florence 151, 155, 159, 166, 168, 191  
 Fonteviva, Neolithic site, Apulia 99  
 Ford, James A. 81  
 Fox, Lady Aileen 18  
 Fox, Sir Cyril 3  
 Fraccaro, Plinio xi, 149, 155, 166-7, 169, 170, 191, 257, 263  
 France, air photography in 39, 41, 43, 75, 84, 147, 207-11, 263-6, Fig. 20, Pls. 50-1, 69-70  
 Frank, Tenney, 157, 163-5, 174, 211, 261  
 Frankfort, H. 110  
 Frederick II, Emperor 89-90, 221  
 Frontinus 150, 152, 213  
 Fuad Safar 72, 74
- Gabriel, A. 277, 279-80, 285  
 Ganshof, F. L. 270  
 Geo-chemical survey 13  
 Gergovia 263-65, Pl. 69  
 Gerkan, von 280, 286  
 Germany, air archaeology in 9, 16, 27, 39, 43, 213, 215, Pl. 12  
 Gibbon, Edward 186  
 Giffen, A. E. van 76  
 Glinde, Holstein 27  
 Glyphada, see Hymettos  
 Goodchild, R. G. xi, 4, 52, 146, 214  
 Gordion, Anatolia 66, 70-1, Pls. 21-3  
 Gray, Mrs. Hamilton 116-17, 133, 134  
 Great Britain, air archaeology (for many additional sites, see works by Allen, Crawford, Richmond, Riley, St. Joseph, etc., cited in the text; see also Monastic sites)  
 England: North  
 Air reconnaissances 7-8  
 Deserted medieval village, East Lilling 25



Great Britain—*continued*

- Hut-circles 18
- Roman forts and camps, Bainbridge 34, Beckfoot 22, Birdoswald 24, Crackenthorpe 23, Housesteads 37, Kirkby Thore 24, Reycross 24
- Romano-British fields, Grassington 37, 44, Langton Wold 84, Yorkshire Wolds 146
- Roman town, Catterick 19
- Strip lynchets, Wharfedale 37
- East
  - Air reconnaissances 4, 8, 17
  - Centuriation, attempts to discover 215
  - 'Cursus' sites 18
  - Deserted Medieval Village, Gainsthorpe 36
  - Earthworks, levelled, Limlow Hill (Iron Age hill fort, etc.) 28, Hoy's Farm (hill fort) 28, Deadman's Hill and Mile Ditches near Royston (linear earthworks) 29
- Essex 17
  - 'Henge' sites, Arminghall 17, 24, Stratford St. Mary 17, Pl. 4 a
  - Mesolithic sites, Shippea Hill 46
  - Ring-ditches 39
  - 'Roddons' 49
  - Romano-British fields and farms, Cantley 17, Pl. 3, Castor (Normangate Field) 20-2, 47, Pl. 4 b, Cottenham 37, Gedney Hill 37, Mill Heath (Cavenham) 20, Welney Washes 43. See also 146-7, 215
  - Roman towns, Caistor 19, Castor (see above), Verulamium 19
  - 'Stockades' 18, 27
- Midlands
  - 'Cursus' sites, Barnack and Maxey 18
  - 'Stockades' 18
- Oxford Region and Upper Thames Valley
  - Air reconnaissances 4, 7-8
  - Crop marks, specimens of differential growth 15, Pl. 1
  - Crop sites at Dorchester recorded in 1722 14
  - 'Cursus' sites 18, North Stoke 23
  - 'Frost cracks', Great Milton 49
  - Gravel terraces, archaeological importance of 17
  - 'Henge' sites, Dorchester 17, 23, 25, 38
  - Iron Age fields and storage pits, Stanton Harcourt 16
  - Ring ditches and barrows 24, Eynsham 16, Pl. 2 a, Highworth 39
  - Roman farms and fields, Ditchley 20, Little Milton 20, 84, Long Wittenham 16, 23, Stanton Harcourt 16, Pl. 2 b, Stonesfield 16
  - Roman town, Alchester 19
  - 'Stockades' 18, Lechlade 19

## South

- Air reconnaissances 4, 7-8
- Ancient fields in strips, Bishopstone, Portland, Twyford Down 37, Thornham Down 38, Worth Matravers 63
- Barrows, Grateley 27, Highworth 39
- 'Celtic' fields 146-7, Berkshire Downs 37, Burderop Down 51, Pertwood Down 34, 38, Windmill Hill 59, Windover Down 35, 63
- Cursus, the 'Dorset' 18
- Enclosures (levelled earthworks), near Barbury Castle 28, End Burgh 29, Little Woodbury (Iron Age farm) 24, 84, Meon Hill 25, Pimperne Down 23
- Hill forts (Iron Age), Ladle Hill 38, (with Bronze Age earthworks) Quarley Hill and Ram's Hill 38, 28
- Neolithic camps 38, Robin Hood's Ball 24
- Portchester, buried buildings 20
- Roman roads, London-Lewes 12, Cliffe and Ripe (limitatio) 215
- Roman towns, Mildenhall 19, Silchester 14, 19
- Trackways, Cherhill Down 38
- Woodhenge 15
- West
  - Cotswolds 18, Shropshire (Celtic fields) 84, Roman town at Wroxeter 18
- South West
  - Devon and Cornwall (ancient fields) 18, 44, Scilly Isles 41-3
- Northern Ireland
  - Dunluce Castle and medieval village site 35, Pl. 11, raths and other air photo sites 35, 43
- Scotland
  - Air reconnaissances 7-8, 14, 18, 20, 37, 52 (see articles cited, for native and Roman sites)
  - Prehistoric sites discovered from National Air Survey photos 8
  - Roman camps and forts 14, Glenlochar 75, Inchtuthill 15
  - Roman field-defences, Woden Law 74
  - Roman roads, Lochmaben 24
  - Strip lynchets 37
- Wales
  - Hut circles 18, Roman roads 38
- Greece, air archaeology in 5, 7, 29-34, 45, 77-8, 275, Fig. 2, Pls. 6-10, 13
- Grenier, A. 147, 207
- Grimes, W. F. 37
- Grinsell, L. V. 39
- Groslier, B. P. 39, 50
- Grousset, R. 185
- Gsell, S. 193, 200, 232-6
- Guy, M. 211

- Haidra (Ammaedara), Tunisia 205-6  
 Harden, D. B. xi, 14, 232-4, 236  
 Haroun-al-Rashid 52  
 Hart, C. A. 11  
 Hatra, Iraq 66, 71-5, Pl. 24  
 Hatt, G. 76  
 Haverfield, F. 23, 215, 225-6, 280  
 Hawkes, C. F. C. x, xi, 13, 38, 74, 141, 147  
 Hawkes, Jacquetta ix  
 Haywood, R. M. 195, 200, 204  
 Hazard, H. W. 189  
 Hearne, T. 14  
 Hemp, W. J. 18  
 'Henge' sites 15, 17, 18, 23-5, 28, 38, Pl. 4 a  
 Herzfeld, E. 53  
 Hey, R. 109  
 Hippodamus, 226, 280, 286  
 Hirigoyen, R. 40  
 Holland 76, 147  
 Holleyman, G. A. 44  
 Holstein, Germany 27, 43  
 Horlaville, M. xi, 194, 199  
 Hornell, James 106-7  
 Hoskins, W. G. 3, 36  
 Houston, J. M. xi  
 Hungary, air archaeology in 78  
 Hunting Aerosurveys xi, 65, 66  
 Hurault, Général xi  
 Hurd, H. P. 235  
 Hvar, island, Dalmatia 7, 109, 151, 156, 183, 191-3, Fig. 18  
 Hyginus 76, 149, 152, 209  
 Hymettos Mt., (Attica), ancient fields on 7, 29-34, Fig. 2, Pls. 6-10  
  
 India 40, 64  
 Indo-China, French 39, 46, 50, 64  
 Infra-red photography 55, 56  
 Inglieri, R. V. 283-5  
 Insall, Wing Commander 15, 24  
 Institut Géographique National, Paris 9, 62, 194, 205  
 Iraq, air archaeology in 51, 59, 62, 226, Pls. 16-19  
 Ives, R. L. 56  
  
 Jackson, Sir T. G. 189  
 Jericho, Jordan 217  
 Johnson, G. R. 80  
 Jope, E. M. xi, 35, 106  
 Jopp, Keith xi, 7, 20  
 Jordan 51-2, 217  
  
 Kahrstedt, U. 9  
 Kambania, Macedonia 45  
 Kandler, P. 175, 179  
 Kenya, air archaeology in 24  
  
 Kenyon, John 19  
 Kharga Oasis, Egypt 47  
 Klinkenburg, J. 215  
 Knowles, D. vii  
 Kondis, I. D. xi, 279, 284  
  
 Lachmann, K. 152, 168, see also Agrimensores  
 Lanciani, R. 248  
 Lantier, R. 236  
 Lauwe, P. Chombart de 7, 8, 9, 46, 61, 264, 271  
 Lavedan, P. 265-6, 268  
 Lear, Edward 132  
 Le Gall, J. 240-1, 245-6, 256  
 Legnazzi, E. N. 175-6  
 Lehmen-Hartleben, K. 231, 233  
 Le Motte, Veneto 268-70, Pls. 66-7  
 Lenormant, F. 89, 218  
 Lepper, F. A. 72  
 Lerici, Ing. C. M. xi, 5, 13, 114, 115, 124, 144, 222  
 Leverhulme Trustees x, 93  
 'Lewis Carroll' (C. L. Dodgson) 57, 213  
 Liber Coloniarum 152, 166, 168, 170, 211-13  
 Limes, Balkan 78-9  
 Lipari, islands of 33, 105, 107, 110  
 Livock, Group Capt. 84  
 Livy 157, 174, 262-3  
 Lloyd, Seton xi, 53, 70  
 Lodi, N.W. Italy, centuriation mapped from air photos 155  
 Lowe, van Riet 46  
 Lugli, G. xi, 41, 113, 154, 212, 245, 248-55  
  
 McBurney, C. 109  
 Macedonia 12, 45, 77, Pl. 13  
 Machiavelli, N. 271  
 MacKendrick, P. 262  
 Maiuri, A. 220-1, 281, 285  
 Malaya, air archaeology in 46  
 Malta 109  
 Mancini, G. 111, 157, 261  
 Maori voyaging 107  
 Marconi, P. 257, 259-60  
 Margary, I. D. xi, 12, 21 seq., 215  
 Marshall, Sir John 64  
 Martonne, E. de 39  
 Marzabotto 166, 226  
 Masada, Israel 13, 74  
 Masseria Fongo, Neolithic site, Apulia 101, Pl. 28  
 Medieval village sites, see Deserted Medieval Villages  
 Mediterranean Islands, Neolithic colonisers of 108-9  
 Megaw, A. H. S. ix  
 Megiddo 52  
 Meiggs, Russell xi, 237, 239, 242, 254  
 Melos 109



- Mengarelli, R. 114, 118, 119, 129, 140-1  
 Metapontum, S.E. Italy, air discoveries at 225  
 Miletus 286  
 Miller, A. A. 37  
 Mohenjodaro 64  
 Mommsep, T. 175, 185, 211  
 Monastic sites in Britain, air photography of vii  
 Monte Abetone (or Abbatone), Cerveteri, Etruscan cemetery at 127-31, 143-4, Figs. 6, 9, Pls. 34-5  
 Moore, J. Grange 42  
 Motya, Sicily 233  
 Myres, Sir J. L. xi, 86, 106, 280, 283  
 Naples 225-6  
 National Air Survey of Britain 8, 38, 57  
 Nea Paphos, Cyprus, buried tombs ix  
 Neolithic voyaging in the Mediterranean 86-7, 105-10  
 Newton, Sir C. T. 283-4  
 New Zealand, air archaeology in 80  
 Nibby, A. 248, 252  
 Nightingale, M. 161, 215  
 Nimrud, Iraq 66-8, Pl. 19  
 Nipsus 213  
 Nogara, B. 112  
 Numantia, Spain 74  
 Obsidian, Neolithic trade in 109-10  
 Oc-Eo, Indo-China, air survey of ancient city 64  
 Olynthus, Greece 223, 226, 284  
 Oman, Sir Charles 270-1  
 Ordnance Survey 8-9  
 Orsi, P. 103  
 Ostia, air archaeology of 7, 11, 28, 43-4, Fig. 23, City 237-41, Pl. 58, Coastline, Tiber, Piana Bella, Isola Sacra (in Roman times) 242-8, Pls. 58-9, 61, Geology of 238, 244-6, 249, 252-5, Pl. 57, Ports of Claudius and Trajan 248-56, Pls. 60-1  
 Ovid 244  
 Pachtere, F. G. de 164  
 Paestum 6, 218-27, Fig. 21, Pls. 52-3  
 Pais, E. 168, 170, 174, 179, 211, 243  
 Pakistan 64  
 Palaeolithic and Mesolithic sites, air archaeology of 46-7  
 Pallottino, M. 111, 112, 118, 131, 132-9  
 Palmanova 172, 270-2, Pl. 68  
 Pantelleria 33, 107  
 Paris, P. 26  
 Paschetto, L. 245  
 Passo di Corvo, Neolithic village near Foggia, Apulia 101-2  
 Patroni, G. 99  
 Patsch, C. 191  
 Pavia 149, 261, 263, Pl. 64  
 Peacock, T. L. 134  
 Peet, T. E. 91  
 Pelham, H. F. 162, 211, 243  
 Penniman, T. K. x  
 Periscope photography; new technique for exploring buried Etruscan tombs 114, 144  
 Persia, air archaeology in 26, 29, 50, 55, 56, 63, 66, 69, Pl. 20  
 Peru, air archaeology in 80  
 Philadelphia, University Museum xi  
 Phillips, C. W. 20, 28, 37  
 Piacenza (Placentia) 153, 157, 261-3, Pl. 63  
 Piganiol, A. 210  
 Piggott, S. 14, 17, 38, 44, 94  
 Pisa 43, 149, 151, 191  
 Pitt Rivers, General vii, ix, 4, 112  
 Pitt Rivers Museum, Oxford xi, 93, 97  
 Pliny 162-5, 250-1, 256, 281  
 Poidebard, A. 4, 7, 26, 30, 40, 41, 50-1, 63-4, 83, 146, 231, 234  
 Pola 7, 151, 155, 175-8  
 Polybius 157, 262  
 Pompeii 225-6  
 Ports, ancient, Salamis (Cyprus) ix, Salpi 36, Ampurias 39, France, Greece, Italy, Syria, N. Africa 41, Pisa and Ravenna 43, Cosa 229, Carthage and Syria 231, Ostia 240 seq., Ragusa 273, Delos 274, Rhodes 280, 282, Pl. 74. See Underwater Archaeology 41-3, also Pls. 54-7, 60, 71-4  
 Portugal, air archaeology in 76  
 Posta Siniscalchi, Neolithic site, Apulia 101, Pl. 27  
 Po Valley, see Centuriation  
 Poverty Point, Louisiana, U.S.A. 81  
 Puglia, see Apulia  
 Puglisi, S. 104  
 Radford, C. A. R. 18  
 Radnoti, A. 78  
 Ragusa 189, 273-4, Pl. 71  
 Ravenna 43  
 Rees, Group Capt., V.C. 51  
 Regolini-Galassi Tomb, Cerveteri 111-12, 133  
 Rellini, U. A. 102  
 Rey, L. 77  
 Rhodes 6, 12, 107, Aerial discovery of Classical street plan in 1950 277, Fig. 25, Pls. 73-5, Confirmed by excavations 279, 284, 286, Discovered by aerial 'total mapping' of minor roads and field boundaries 279-80, 282-4 (and of the streets in the medieval city 285-6), Limits of Classical city 281, Medieval gates and ramparts sited on Classical streets 285-6, References to city by Classical authors 279-81, Site of silted ancient harbour Pl. 74

- Rhodes, P. P. 8, 37  
 Rhodesia, air archaeology in 27, 80  
 Rich, J. L. 14  
 Richmond, I. A. xi, 23-4, 77, 210, 256-60  
 Ridola, D. 91, 95, 99, 102-3  
 Riley, D. N. 7, 8, 18, 19, 23, 39  
 River beds, ancient, Meanders 28, Mesolithic 46.  
 'Roddons' 49, Nimrud 68, Valence 209, Ostia  
 238-250, Verona 257, Lucca 259. See also Figs.  
 23-4, Pls. 5, 58, 61, 62  
 Robinson, D. M. 223, 284  
 Romanelli, P. 131, 135  
 Roman 'villas' and farms, Europe 16-17, 20, 67,  
 84, 147-8, 176, Pl. 3, Tunisia 206  
 Rostovtseff, M. 26, 71, 177, 190  
 Roumania, air archaeology in 78-9  
 Roussel, P. 275  
 Royal Air Force vii, ix, 8, 52, 84  
 Russell, E. W. 16  
 Russia, air archaeology in 81-2  
 Ryme Intrinseca, Dorset Fig. 3
- Säflund, G. 220  
 Saigon, Indo-China 26  
 Salamis, Cyprus ix, 44, 214  
 Salisbury, Sir Edward 25  
 Salona, Dalmatia 7, 150, 156, 183-93, Fig. 17,  
 Pls. 44-6  
 Salonika area, see Macedonia  
 Salpi, Apulia, site of ancient town and port 36  
 Samarra, 50, 52-3, Pl. 17  
 San Lorenzo, Apulia, site of medieval village and  
 palace 36  
 Sardinia, air archaeology in 5, 77  
 Saumagne, Charles xi, 4, 41, 194-5, 200, 202, 205,  
 236-7  
 Schmidt, E. 26, 29, 50, 54, 56, 63-4  
 Schulten, A. 150, 154, 157, 167, 175-6, 193, 195,  
 197-8, 201, 211, 213  
 Scilly Islands 41-3  
 Scope and Limitations of Aerial Search, see Air  
 Archaeology  
 Semple, E. C. 107  
 S. Fuoco d'Angelone, Neolithic site, Apulia 99,  
 Pl. 25  
 Segre, E. 114  
 Sereth (Siret) River, Roumania 79  
 Servius 163  
 Sestieri, P. C. xi, 220-2, 224, 226  
 'Sherlock Holmes' 66  
 Siam, air archaeology in 26  
 Sian-fu (Chang'an), China 52  
 Sicily 7, 77, 103, 105  
 Siculus Flaccus 152, 212  
 Sidon 41, 231  
 Silchester 14, 19
- Sisupalgahr 64  
 Society of Antiquaries of London 86, 93, 156, 270  
 Solta, I., Dalmatia 193  
 Somaliland, ancient cities ix, 49  
 Somme Valley, discoveries in 7, 75  
 Spain, air archaeology in, 5, 39, 74, 76-7, 147, 229  
 Stanton Harcourt, Oxon. 16, Pl. 2 b  
 Steer, K. 8  
 Steers, J. A. 237, 254  
 Stein, Sir Aurel 26, 71  
 Stereoscopes 59-63, 92, 115  
 Stevens, C. E. xi, 147-8, 210, 215, 265  
 Stevenson, R. B. K. 97, 102  
 St. Joseph, J. K. vii, 4, 7, 8, 9, 15, 18, 19, 35-6, 38,  
 74, 84  
 'Stockades' (England) 15, 18  
 Stokkerup, Denmark 13  
 Strabo 240, 279, 281  
 Stratford St. Mary, Suffolk, 'Henge' site 17, Pl. 4 a  
 Strip-lynchets, Scotland, Yorkshire, Wiltshire 37-8,  
 Dorset 63  
 Stucchi, S. 170-1  
 Stukeley, William, observations on crop-sites 1719,  
 14  
 Sudan 80  
 Suetonius 250  
 Switzerland, air archaeology in 75, 215  
 Syria 26, 30, 41, 51, 63, 83, 146
- Tarquinius, Monterozzi cemetery, aerial dis-  
 coveries at 112-13, 131-9, 143-4, Fig. 10, Pls.  
 36-7  
 Taxila 64  
 Tchoga Zambil (Persia) 66, 68, Pl. 20  
 Tennyson, Lord Alfred 84  
 Terraced fields, in Mediterranean lands 29 seq.,  
 77, 191, Rhodesia 80  
 Terremare, Po Valley 77  
 Thulin, C. 152  
 Tolstov, S. P. 82  
 Tortona, N.W. Italy, centuriation mapped from  
 air photos 155  
 Toutain, J. 206  
 Tráchones, see Hymettos  
 Transhumance, hill pastures and resources 100,  
 104, 162, 190  
 Transvaal, S. Africa 46  
 Treviso, see Centuriation  
 Tricesimo 170-4, Fig. 14  
 Tripolye cultures, Ukraine 98  
 Trogir, see Centuriation  
 Tughlaqabad 64  
 Tunisia, Roman 148-9, 153-4, 168, 193-207,  
 Fig. 19 (see also Centuriation)  
 North (see also Carthage) 40, 197-200, 231-7,  
 Pl. 48



Tunisia—*continued*

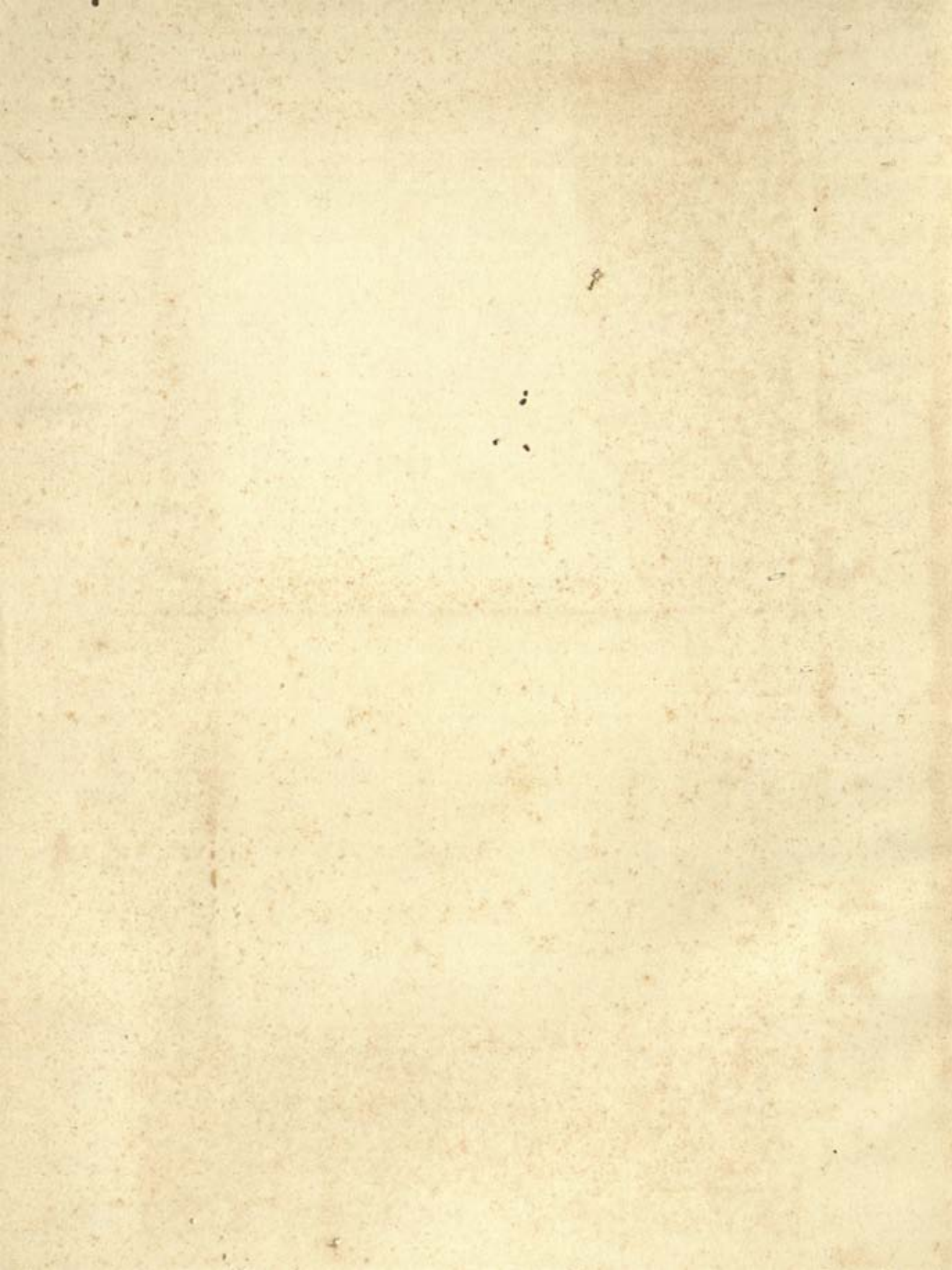
- Central 194, 200-5, Pl. 49  
 West 205-6  
 South 195, 198, 206  
 Medieval 198, 203  
 Turkey 5, see also Anatolia  
 Tyre 41, 231
- Uganda, Bigo earthworks 80  
 Ugljan Island, Dalmatia, ancient field-system  
 discovered from air photos 7, 156, 183, Fig. 15  
 Underwater archaeology 41-3, 276  
 U.N.E.S.C.O. x  
 U.S.A., air archaeology in 80-1
- Valence 7, 146, 207-11, 215, Fig. 20, Pls. 50-1  
 Varro 162, 164-5  
 Vaufray, R. x  
 Veii, Etruria, ancient roads located from air  
 photos 48, Pl. 14  
 Veleia, importance of hill-country in ancient  
 economy (see Transhumance) 163  
 Vergil 162, 246  
 Verona 11, 256-261, Fig. 24, Pl. 62  
 Via Aemilia 157-8, 261-3, Pls. 38, 63  
 Via Postumia 160, 257, 262, 268, Pl. 63  
 Vignate Fraccacreta, Apulia, Neolithic village  
 found from air photos 96-7  
 Vix, France, levelled tumuli 76

- Voghera, N.W. Italy, centuriation mapped from  
 air photos 155  
 Voinovitch, L. de 186  
 Volturno, ancient river's mouth 245  
 Vosges, ancient fields 147  
 Vulci, Etruria, aerial discoveries 7, 77, 115

- Walker, F. 49  
 Ward Perkins, J. B. x, 48, 52, 217  
 Warmington, B. H. 204  
 Weatherhead, Tristram 65  
 Wheeler, Sir Mortimer vii, viii, xi, 3, 4, 52, 80, 93  
 Whitaker, J. I. S. 233  
 Wiegand, T. 52  
 Williams-Hunt, P. 20, 26, 46, 50, 88, 97, 99, 101  
 Wilson, Alan 188  
 Witthoft, John 81  
 'Works of the Old Men', Trans-Jordan 51-2  
 World Air Photo Coverage 79  
 Wycherley, R. E. 223, 280
- Young, J. H. 34  
 Young, Rodney xi, 70

- Zairwan, Roman road nr. Singara, Iraq 51, Pl. 18  
 Zambotti, P. Laviosa 102  
 Zara, Dalmatia, Centuriation found from air  
 photos 7, 149-50, 156, 178-83, 187, Fig. 15-16,  
 Pls. 42-3







Central Archaeological Library,  
NEW DELHI.

Call No. 913/Bre

Author— 17783

Title— Ancient Landscapes

| Borrower No.  | Date of Issue | Date of Return |
|---------------|---------------|----------------|
| S. R. K. Pant | 16-8-61       | 18-8-61        |

*"A book that is shut is but a block"*

CENTRAL ARCHAEOLOGICAL LIBRARY  
GOVT. OF INDIA  
Department of Archaeology  
NEW DELHI.

Please help us to keep the book  
clean and moving.